Energy Strategies for Rural India: Evidence from Six States

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Preface

This study was initiated in response to concern that people in rural areas of India were not progressing toward modern energy use or modern use of biomass fuels. Rather than focusing on specific technologies, it set out to examine all forms of energy use, including renewable energy, and to determine whether households in rural areas have access to modern forms of energy use. In addition, it specifically targeted its analysis and recommendations toward poor households, who spend a significant proportion of their time and income on energy. (A more in-depth study of women and energy will follow this report.) The project was implemented by the Energy Sector Management Assistance Programme (ESMAP), with fieldwork cofinanced by the World Bank and the Government of The Netherlands.

The study complements much of the ongoing rural energy work in India. One of its strengths is that it moves beyond a sole focus on rural energy toward broader policy implications. The fieldwork consisted of a household energy survey of more than 5,000 households living in 180 villages in six states, surveys of commercial and small-scale industrial establishments, field visits to rural areas, interviews with representatives of selected stove programs, a survey of renewable-energy manufacturers, and an assessment of rural biomass resources based on secondary sources. (During the course of the study, numerous consultations were held with government officials, who generously shared their time with both the local and international teams; the staff of the Ministry of Non-Conventional Energy Sources was especially supportive of this work.)

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Abbreviations and Acronyms

ARPU	Agro-climatic Regional Unit
ARTI	Appropriate Rural Technology Institute
ASTRA	Centre for Application of Science and Technology for Rural Areas
BIS	Bureau of Indian Standards
Cal	kilocalorie
CASTFORD	Centre for Application of Science and Technology for Rural Development
CERC	Central Electricity Regulatory Commission
CMIE	Centre for Monitoring of India Economy
ERCO	Electricity Regulatory Commission Ordinance
ESMAP	Energy Sector Management Assistance Programme
GTZ	German Agency for Technical Cooperation (Deutsche Gesellschaft für Technische Zusammenarbeit)
ha	hectare
HIMURJA	Himachal Pradesh Energy Nodal Agency
kg	kilogram
KgOE	kilogram of oil equivalent
klm	kilolumen
km	kilometer
kV	kilovolt
kW	kilowatt
kWh	kilowatt hour
l	liter
LPG	liquefied petroleum gas
MJ	megajoule
mt	metric ton
MW	megawatt
MWh	megawatt hour
na	not available
neg	negligible
NGO	nongovernmental organization
NRSE	New and Renewable Energy Sources
ODA	Overseas Development Agency (U.K.)
ORG	Operations Research Group
PV	photovoltaics
Rs.	rupees
SEB	State Electricity Board
SERC	State Electricity Regulatory Commission
sq km	square kilometer
TERI	Tata Energy Research Institute

TOE	tonnes of oil equivalent
TWh	terawatt hour
USAID	United States Agency for International Development

Currency Equivalents

1998

US$1 (dollar) = Rs.34 (Indian rupees)

Energy Conversion Factors

	Energy content			*Efficiency for cooking*
Fuel type	*MJ*	*KgOE*	*Cal*	*%*
LPG (kg)	45.0	1.059	10,800	60
Electricity (kWh)	3.6	0.085	860	75
Kerosene (l)	35.0	0.824	8,400	35
Charcoal (kg), 5% moisture content, 4% ash	30.0	0.706	7,200	22
Wood (kg), 15% moisture content, 1% ash	16.0	0.376	3,840	15
Coal (kg) (can vary significantly)	23.0	0.541	5,520	na
Dung (kg) 15% moisture content, 20% ash	14.5	0.341	3,480	na
Straw (kg) 5% moisture content, 4% ash	13.5	0.318	3,240	na

Executive Summary

1. Despite rapid rates of urbanization, 74% of India's people (some 120 million households) reside in rural areas. Most rural villagers still depend predominantly on so-called traditional fuels to meet their modest energy needs. Fuelwood, crop wastes, and dung are used for cooking and cottage industries, even in rural areas with access to modern fuels. Human labor and animals provide much of the energy used in transportation, agriculture, and artisan activities, while some commercial fuels are used for lighting.

2. Fuelwood, crop wastes, dung, and other traditional fuels, as presently used, have inherent disadvantages. Collection is arduous and time-consuming, combustion is difficult to control, and cooking methods capture only a fraction of these fuels' available energy. Cooking with fuelwood on a traditional open fire, for example, captures only about 15% of the wood's thermal content, compared to the 60% captured when cooking with liquefied petroleum gas (LPG). Human and animal labor, also arduous, limit increases in productivity.

3. Traditional fuel use may also have serious consequences for human health and the environment. For example, cooking with woodfuels on an open fire within a confined space can lead to acute respiratory problems, particularly for women and children. Highlighting the possible seriousness of this problem, some recent health-sector studies indicate that cooking smoke may be responsible for more than 400,000 premature deaths annually in India. An increasing population and other pressures have caused the demand for traditional fuels to exceed sustainable supply, leading to resource degradation and deforestation. Overuse of forest resources is leading to further environmental damage, such as leaching of soil nutrients, erosion, and flooding. If excessive quantities of crop and animal residues are burned rather than returned to the soil as fertilizer, agricultural productivity can drop.

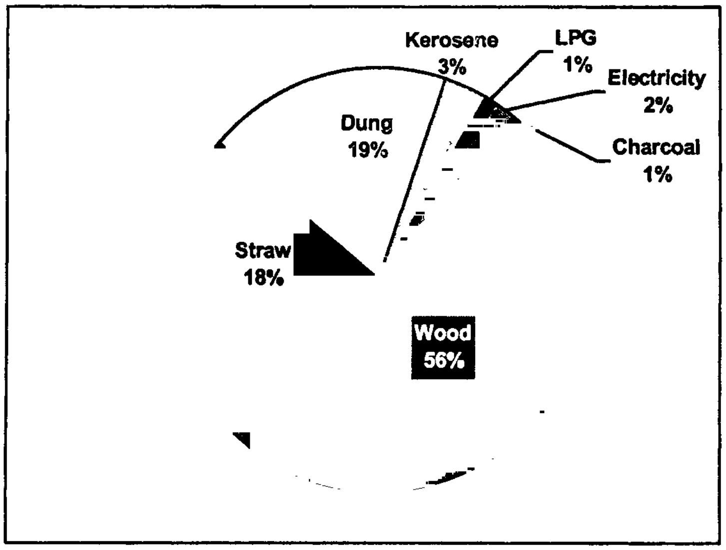
Rural Energy-use Patterns

4. India's rural people have been slow to change the way they use energy, particularly when compared to the country's urban residents, who have rapidly changed. By contrast, rural households, even prosperous ones, continue to depend on traditional fuels, supplemented by small amounts of kerosene and electricity for lighting, to meet most of their energy needs. With some exceptions—notably in the state of Punjab—energy use in agriculture, artisan activities, and transportation is still largely provided by human and animal labor.

5. Nonetheless, some significant, even rapid, changes in energy use have occurred. Electrification of pumpsets for irrigation has expanded rapidly. Introduction of LPG in areas threatened by deforestation has made greater penetrations than expected. And expanded availability of electricity in rural areas has made possible the greater adoption, albeit uneven, of appliances, including television sets and electric fans.

6. Despite such advances in rural energy use, traditional fuels remain the main source of household cooking energy. Because cooking requires such a large amount of energy, these fuels dominate the aggregate energy consumption of typical rural households. As indicated in Figure E-1, traditional fuels dominate the overall share of rural energy use, accounting for more than 90% of total use, while modern fuels are used to meet lighting, cooling, and other non-cooking needs.

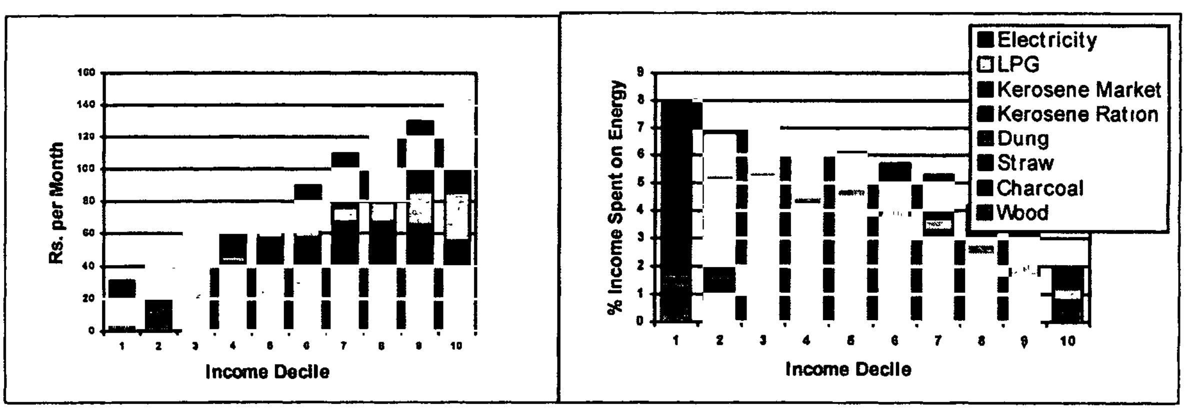
Figure E-1 Energy Use in Six States of India, 1996



Source: ORG Household Survey, 1996.

7. Income differences play an important role in the energy and appliances mix in rural households. As might be expected, wealthier households spend a larger cash amount than do poorer households on energy, but this amount represents a smaller percentage of their income (Figure E-2). Conversely, the cash amount poor households spend on energy represents a significant percentage of their income. Thus, even low expenditures on energy create a great burden for the rural poor.

Figure E-2 Energy Expenditures and Use by Income Class in Rural India



Government Programs

8. The Government of India has developed various programs to assist rural people in meeting their energy needs. These include a public distribution program for kerosene, a rural electrification program, a special program to encourage use of LPG in hilly regions, and programs that encourage greater use of renewable energy. For each sector, this study identifies

the major problems, along with past and current policy regimes, as well as areas where change is needed if access to modern, efficient energy is to improve.

9. Petroleum fuels are not extensively used in rural areas, with the exception of kerosene, which is distributed at the monthly rate of about 4 liters (l) per household through the public distribution program. Traditionally, government policies have favored marketing petroleum products in urban areas, where people are allowed to purchase 15 l of kerosene per month, which is enough for cooking, and LPG is made available at subsidized prices. Until recently, LPG was not marketed in rural areas; consequently, few rural households use it. At the time of this study, most of the well over US$1 billion annual subsidy for LPG went to higher-income households. Today, with the rise in international petroleum products, the subsidy has reached US$3 billion annually and continues to be directed mainly to higher-income households.

10. Of all governmental rural energy programs, the rural electrification program has probably had the greatest effect. Introduction of electricity has vastly improved the quality of lighting and has permitted increased use of electric fans, television sets, irons, and other appliances. Electrification of pumpsets has promoted major increases in agricultural productivity and rural incomes. But widespread subsidization has weakened the financial standing of the State Electricity Boards (SEBs) and led to deterioration in electricity service. Despite such problems, the rural electrification program is beginning to reach a significant number of poor households, who use electricity mainly for lighting. Far superior to kerosene lamps, electric lighting significantly benefits rural households, particularly women.[1]

11. India's renewable energy program has been more active than those in most other developing countries. Although the programs carried out by the Ministry of Non-Conventional Energy Sources have been evolving into more market-oriented approaches, many existing programs are still driven by targets and extensive subsidies. Low penetration of renewable energy devices into rural areas persists, despite the allocation of substantial resources to the program.

12. Biomass remains, by far, the predominant fuel for rural households. Rural residents interviewed in this study expressed concern about rising fuelwood shortages, which force poorer households to turn to dung and crop residues and commercialized fuelwood supplies. Most government programs aim at preserving forests or encouraging villagers to maintain them. In addition, the Ministry of Non-Conventional Energy Sources promotes improved stove programs.

Policies and Programs for Energy Development and To Assist the Poor

13. The energy scene in India, which has been changing significantly in recent years, includes a significant trend toward liberalization of energy markets. Although the process has been slow and has a long way to go, it has spurred positive developments in rural markets, which are anticipated to continue into the future. Policies and programs to assist in developing energy markets include electricity, biomass and forestry, petroleum fuels, and renewable energy.

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1 Women in electrified households are three-to-four times more likely to read, even after controlling for income and other household characteristics.

Problems and Opportunities for Rural Electrification

14. Recent developments in India's electricity sector reform are likely to change the way the country generates and distributes electricity. One goal of the reforms is to focus more on customer service through greater system efficiency and reliability. However, in the near term, the reforms will not solve the problems of rural electrification. In fact, based on evidence in other countries, the reform process often fails to adequately address the problems of poor households.

15. The grid electrification program has had remarkable success in extending lines to rural people and in promoting agricultural development. Unfortunately, the program has fallen short of expectations for delivery of electricity services. Although electricity has reached more than 90% of India's villages, only about 40% of rural residents have adopted it. Most of the remaining unelectrified households are poor.

16. Although politically complex, the electricity situation has several possible solutions. One would be to encourage the development of community, regional, or private electricity-distribution companies that, with appropriate incentives, could be more responsive to the needs of rural populations. A second option would be to create a special lifeline rate, since poor people use so little electricity, generally less that 20 kilowatt hours (kWh) per month. For example, a monthly lifeline rate of 10-15 kWh would encourage poor households to adopt electricity. Such a service level would be enough to power two light bulbs and a radio or black-and-white television set. The loss to electricity companies would be insignificant, and could easily be recovered through cross-subsidies. However, the quality of life for poor rural households would improve greatly. A third solution would be to develop technical design innovations for poor households, such as low-cost distribution methods that could be associated with lifeline rates and low-service initiation fees.

17. Thus, reforms should not be limited to large companies, but should consider creating an environment in which smaller distribution companies are encouraged to provide service to rural markets. An essential part of this reform would be the ability of companies to have cost-covering pricing, which would include elimination of cross-subsidies directed toward modestly well-off farmers.

Petroleum Products: Urban Bias in Cooking Fuels Policy

18. The retail and distribution system for kerosene and LPG has greatly restricted access to these fuels in rural areas. Kerosene is available in limited quantities through the ration program, and the network of LPG distributors is focused on urban areas. This study found that the market for LPG was larger than expected in wealthier states. It revealed that more rural people would use LPG if it were readily available. In rural Himachal Pradesh, for example, where LPG restrictions have been reduced and sales have been encouraged in order to reduce pressure on local forests, many people have started using LPG for cooking.[2] The study also showed that LPG subsidies are directed mainly to wealthier urban consumers.

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2 The effect on deforestation rates is uncertain.

19. Most LPG is sold through government-affiliated retailers. The private sector is now allowed to import and sell LPG at market rates, which presently are significantly higher than those of government retailers. This study recommends continuing the liberalization of LPG retailing and eliminating incentives that work against expanding service to rural areas. In the near future, most of the poorest households will not use great quantities of LPG for cooking because of the high front-end costs of cooking equipment and storage bottles, as well as the lack of a developed rural distribution network. Nonetheless, LPG can be made more affordable to a wider range of people. For example, spreading payments over time can reduce the initial costs of stoves to consumers, and LPG can be bottled in a wider range of sizes so that more people have enough ready cash to purchase it.

20. The kerosene subsidy in India aims squarely at the rural lighting market and is reaching poor rural households. As indicated above, the kerosene ration for urban families is 15 l per month, while the ration for rural households is only 4 l per month. But the rationale for subsidizing kerosene for lighting is outmoded in most areas where electricity is available. India is now at a stage where higher-income households have access to and use electricity in their daily lives. The main infrastructure investments are in place to serve a substantial remaining proportion of the population—mainly lower-income, rural residents. Given the appropriateness of targeting subsidies to poor populations and the tremendous benefits that switching from kerosene to electricity for lighting can bring, it is time to consider redirecting the kerosene subsidy to the electricity sector. This could be achieved through grid intensification and promotion and through marketing renewable-energy systems for rural areas.

Facing Local Biomass Shortages

21. Biomass is, by far, the most widely used form of renewable energy in India today, but local problems are involved in its supply and demand. The people that still use biomass for cooking are the very poorest urban households and most rural ones. This study found that, in addition to the indoor air pollution caused by biomass cooking, rural people spend significant amounts of time collecting biomass. Rural people believe there is a growing scarcity of quality fuelwood, a perception supported by state biomass supply trends. Today, rural people who switch to kerosene and LPG for cooking spend about one hour per day collecting fuelwood and purchasing commercial wood at local markets. Addressing local biomass shortages involves growing more wood for local use; burning wood more efficiently using improved biomass stoves (which reduce indoor air pollution); and using substitute fuels, such as kerosene and LPG.

22. Emphasis on joint forest management should continue. Such programs allow local villagers to cooperate with forestry officials in managing and protecting nearby forests in return for a portion of the revenue and products those forests generate. Currently, joint forest management programs are directed only toward villages that reside in or near forests; however, in India, most villages—many of which are experiencing fuelwood shortages—are located far from forests. It should be possible to design similar programs for managing trees located outside the forests. Any such programs should be directed to areas with the greatest fuelwood shortages.

23. Improved biomass stoves have been designed to reduce biomass consumption and reduce indoor air pollution. Although these two outcomes are sometimes not entirely compatible, a multitude of designs accommodating various types of end uses and cooking styles

can be developed. Given the emerging evidence of cooking smoke's harmful effect on human health, improved biomass stoves can serve as an important bridge to the use of more convenient fuels in the future.

24. Unfortunately, India's improved stove program has achieved less than it should have. However, with appropriate technical assistance, a wider variety of improved stoves can be developed to meet the needs of rural households. Such programs do not require huge investments, but can significantly affect time use, quality of the indoor environment, and supply of local resources. The most successful programs include technical assistance in research and development of improved stoves, training of potters, and information dissemination. This study recommends learning from the country's most successful programs in order to expand the reach of the improved stove program.

Evolution of the Approach for Renewable Energy

25. Presently, little evidence indicates that modern renewable energy plays a significant role in rural India. To date, the government program for promoting and disseminating renewable energy has been oriented toward pilot projects, dissemination targets, and direct subsidies. In the early stages of product development, pilot projects to test new technologies could be justified. But today, most renewable energy technologies have moved beyond the product-testing phase. It is therefore recommended that programs shift to supporting market development rather than the technologies themselves. Within the rural context, the authors recommend broadening the scope of support for development of businesses involved in renewable energy technologies and adopting a market-oriented approach to sales and distribution.

1

Introduction

1.1 Despite rapid urbanization, 74% of India's people—some 120 million households—still reside in rural areas. As this report shows, energy use in India's villages varies considerably, as does access to commercial fuels. Most villagers still depend predominantly on so-called traditional fuels to meet their modest energy needs. Fuelwood, crop residues, and dung are used for cooking and cottage industries, even in rural areas with access to modern fuels. Human labor and animals provide much of the energy used in transportation, agriculture, and artisan activities.

1.2 Traditional fuels, as presently used, have inherent disadvantages. Collection is arduous and time-consuming, combustion is difficult to control, and cooking methods capture only a fraction of the fuels' available energy. Cooking with fuelwood on a traditional open fire, for example, captures only about 15% of the wood's thermal content, compared with the 60% captured when cooking with gas. Human and animal labor, also arduous, limit increases in productivity.

1.3 Use of traditional fuels may also have serious consequences for human health and the environment. Cooking with woodfuel on an open fire within a confined space can lead to acute respiratory problems, particularly for women and children. Underscoring the potential seriousness of this problem, some recent health-sector studies indicate that cooking smoke may be responsible for more than 400,000 premature deaths annually in India. An increasing population and other pressures have caused the demand for traditional fuels to exceed sustainable supply, as well as resource degradation and deforestation. Overuse of forest resources can cause environmental damage, such as leaching of soil nutrients, erosion, and flooding. When crop and animal residues are burned in excessive quantities rather than returned to the soil as fertilizer, agricultural productivity can drop.

1.4 Traditional and animate-energy patterns, while adequate for maintaining a subsistence existence at low population densities, are ill suited to providing modern amenities and supporting the more intensive agricultural productivity needed to sustain a higher standard of living of growing rural populations. It is generally accepted that further integration of rural communities into the economic, social, and political life of the nation will require modern, efficient forms of energy and energy-using equipment.

1.5 India stands at the forefront of developing-country governments that have recognized the need to provide rural populations improved energy supplies (World Bank 1996).

However, this task has proven difficult because poor rural populations cannot afford expensive forms of energy, and the logistics of supplying rural areas are difficult, increasing energy costs.

1.6 Though agricultural productivity has improved dramatically in some areas of India, notably in Punjab, most rural households remain poor. An estimated 80% of India's farmers own less than 2 hectares (ha) of land and practice subsistence farming, which produces little surplus for purchasing commercial energy. From a national point of view, traditional fuels are expensive to use if the collection time and environmental damage they cause are included. To the traditional fuel user, however, supplies appear to be gathered free of charge by family members who may not have alternatives for paid use of their time. The attachment to traditional fuels for reasons of cost, and perhaps culture, is noticeable, even in areas where commercial fuels are readily available.

1.7 Logistics are a critical obstacle to supplying rural energy. While India's urban towns and cities are full of poor people, a high proportion has access to commercial fuels because distribution costs of electricity and petroleum products can be kept low in densely populated areas adjacent to developed urban infrastructure and energy-producing facilities. In the case of electricity, it also may be easier to subsidize poor urban consumers (by providing lifeline rates or similar services) within a service area that contains large, affluent users.

1.8 The cost of distributing commercial fuels rises sharply in remote, sparsely populated rural areas. Many such areas are virtually inaccessible, largely because of mountainous terrain and lack of all-weather roads. Even in areas well served by roads or located close to transmission systems, distribution costs can be prohibitively high because so few residents must bear the cost of the extensive distribution system needed to cover sparsely populated areas.

1.9 Providing improved rural energy is being addressed in three ways. The first way is to subsidize rural users so that they pay far less than the actual cost of connecting to the system. This may be a viable solution in most industrialized countries, where rural populations are relatively small; but in India, where more than 70% of people live in rural areas, extensive subsidies entail enormous fiscal charges. The second way is to emphasize decentralized or renewable systems based on locally available resources (e.g., solar, wind, or minihydro) that reduce logistical requirements and cut distribution costs. The third way is to improve supplies and efficiencies of traditional fuels as a basis for sustainable energy supplies. For example, modern uses of biomass can yield biogas, alcohol, and charcoal, as well as provide fuels for electricity generation. Also, improved cooking stoves can reduce air pollution and fuel requirements.

1.10 Despite the difficulties inherent in providing access to improved rural-energy supplies, the Government of India has progressed considerably in some areas, among which rural electrification is the best documented. From 1951 to 1995, the number of electrified villages rose from 3,000 to 500,000. Electrification of pumpsets, particularly in Punjab, has been highly effective, contributing to a spectacular increase in agricultural productivity and living standard.[2]

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[3] Increased agricultural productivity has helped decrease the rate of deforestation as higher crop yields per unit area mean that less new land is required to satisfy a growing population's demand for food supplies.

Within villages, however, household connections have lagged, and two-thirds of India's households remain without access to electricity.

1.11 Other regions have not benefited nearly to the same extent. The value of commercial fuels lies in their ability to improve productive efficiency and promote social programs, such as health and education. Under certain village conditions, improved fuels are the sole catalyst for social and economic improvement (this was also the case in many rural areas of industrialized countries). More typically, however, improved fuels are a necessary, but insufficient, condition for rural progress, and must be supplemented by agricultural-improvement, health, and education programs, which add to the cost and complexity of rural energy programs. Poor populations in towns and citites, on the other hand, are more likely to have access to certain health and educational opportunities, and can therefore benefit more effectively from improved energy supplies.

Survey and Background Studies

1.12 Given the importance of improving access to modern and efficient forms of energy and energy-using devices, this study examined opportunities for and barriers to developing rural-energy markets in India. Specifically, the study was guided by the following objectives:

- Examine rural-energy consumption patterns in sample households of selected villages,
- Estimate the energy needs in rural regions,
- Examine the factors underlying fuel preferences,
- Review existing policy initiatives for improving energy availability,
- Review status of rural electrification programs at household and farm levels,
- Examine penetration of non-conventional sources of energy,
- Document the opinions and attitudes of the rural population regarding currently available forms of energy and potential alternatives,
- Document time-use patterns of women who use various fuels for domestic activities, and
- Suggest new policies for improving energy availability.

1.13 To achieve these ambitious goals, a survey was conducted in six states that represent the diversity of India. The survey consisted of more than 5,000 household interviews, visits to some 900 rural artisans and industries, selective physical measurements of traditional fuel consumption, a census of more than 52,000 households in the selected villages, and collected secondary information (Appendix). The survey was able to take advantage of a previous study on rural energy in India conducted in 1980. As a consequence, the sample for the survey should be considered as representative of the states, but should not be considered a strictly accurate estimate of population averages. However, the authors have checked the averages of other studies, and, for all practical purposes, have found that the survey results are representative of the states. This wealth of information has enabled this report to identify significant problems in rural energy development and to suggest solutions in the form of appropriate programs.

Background of the Six States Surveyed

1.14 The six states surveyed were chosen to provide a wide range of climatic, topographic, and socioeconomic development. They are Andhra Pradesh, Himachal Pradesh, Maharashtra, Punjab, Rajasthan, and West Bengal (see Map 1, IBRD 31220). Population densities vary widely among these states, from 77 per square kilometer (sq km) in Himachal Pradesh to over 600 per sq km in West Bengal (Table 1.1). Likewise, the agricultural resource base varies considerably among states. For example, Andhra Pradesh, located in the southeast, contains a subhumid coastal region on the Bay of Bengal, which changes into the semi-arid Deccan Plateau. Soils vary from coastal alluvial to red sandy and loamy in the highland areas. The state of Maharashtra, which adjoins Andhra Pradesh and stretches westward to the Indian Ocean, is largely semi-arid. West Bengal, stretching from the Bay of Bengal northward to the Himalayas, has a humid climate, and the southern part benefits from the rich soils resulting from alluvial deposits of such major river systems as the Ganges and the Brahmaputra.

1.15 Although contiguous, the three northernmost states—Rajasthan, Punjab, and Himachal Pradesh—differ considerably. More than one-third of Rajasthan is desert, and shortage of water is a major obstacle to the region's development. Punjab, to the north of Rajasthan, is an agricultural success story. Though rainfall is minimal, irrigation has permitted much of the land area to be brought under efficient and productive cultivation. Himachal Pradesh, in the western Himalayas, enjoys a mostly temperate climate, and its many rivers deposit alluvial soils in the valleys.

1.16 Productivity of labor in Punjabi agriculture is five times higher than in the other states surveyed because productivity of land is more concentrated. Punjab is closely followed by West Bengal and Andhra Pradesh, where highly labor-intensive cropping patterns are followed.

1.17 Differences in population densities, climatic resources, and agricultural development are reflected in the diverse social and economic environment of the rural populations. Punjab, Himachal Pradesh, and Rajasthan have the highest rural household incomes, roughly twice that of other states, which also have the highest rates of rural poverty (Table 1.1). Rajasthan's rate of rural poverty, also high, suggests that this state has a more unequal income distribution than others, given its high mean income.

1.18 Educational attainment tends to follow the level of household income, with two exceptions: 1) Rajasthan, which has a higher illiteracy rate than might be predicted by its higher income and 2) Maharashtra, which has a lower illiteracy rate. The higher degree of economic development in Punjab is illustrated by the state's comparatively high level of housing—52% of houses are *pucca* (i.e., constructed of bricks or similar materials) compared with 9-15% in the other five states.

Map 1. Sample Districts in Rural Energy Survey, India, 1966

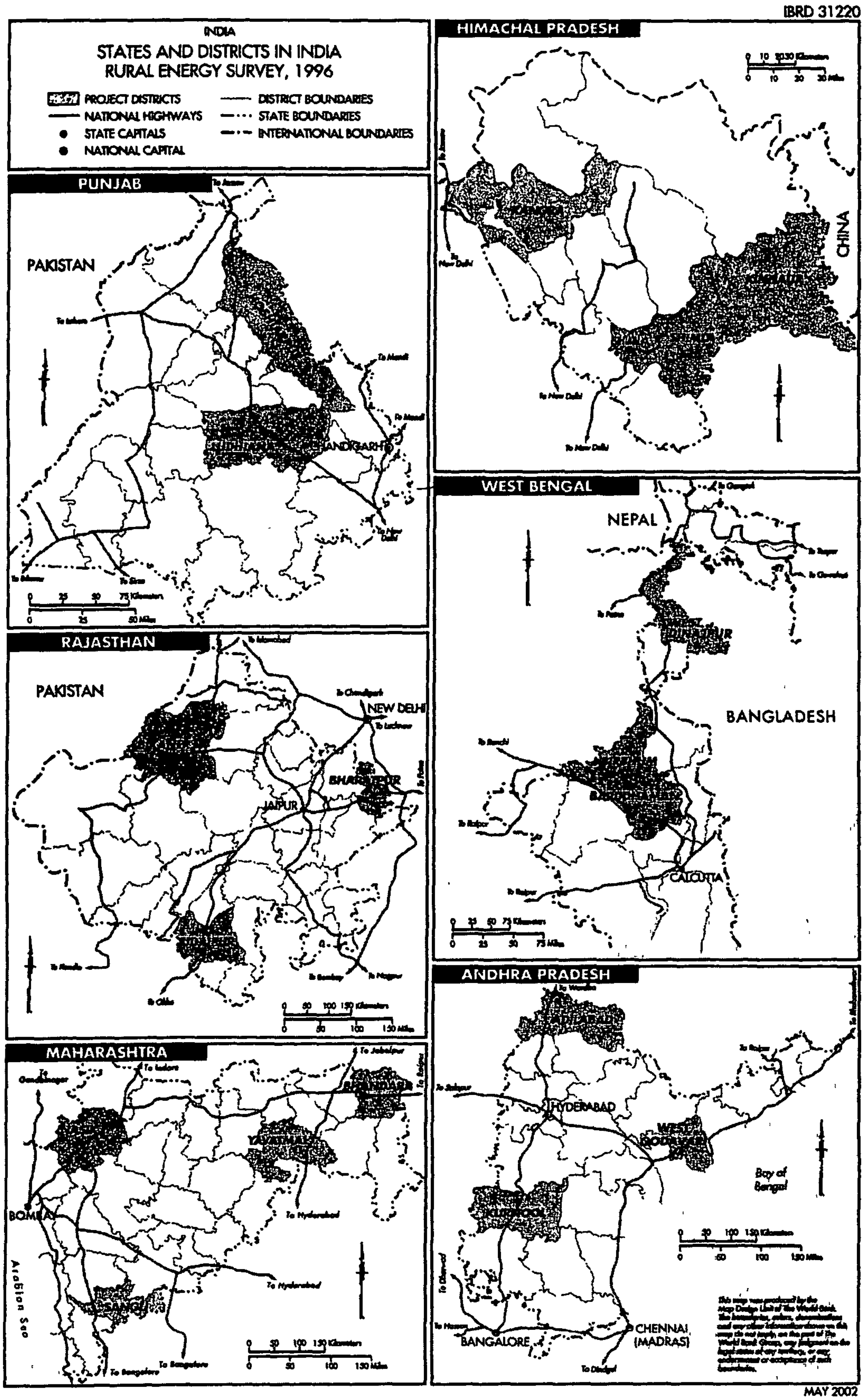


Table 1.1 Economic and Social Indicators for the Six States Surveyed, 1997

Economic and social indicators	*Andhra Pradesh*	*Himachal Pradesh*	*Maharashtra*	*Punjab*	*Rajasthan*	*West Bengal*
Land area (million ha)	27.5	5.6	30.8	5.0	34.3	8.9
Forested area (million ha)	4.7	1.3	4.4	0.1	1.3	0.8
Total population (million)	72.2	5.7	85.8	23.3	47.6	74.1
Population density (per sq km)	195	77	204	333	100	615
Rural population (%)	77	92	65	72	79	74
Rural poverty (%)	39	25	42	11	37	40
Pucca housing (% of total)[a]	14	15	2	52	15	9
Households with electricity connection (% of total)[b]	64	96	65	94	33	22
Mean annual household income (Rs., 1996)	17,322	40,724	24,236	41,149	34,551	20,427
Illiteracy (%)	18	6	9	4	18	13
Agricultural labor productivity (Rs. per capita)	1,855	na	2,133	10,009	2,349	2,323
Land productivity (Rs. per ha)	4,734	2,344	3,022	6,372	1,424	5,275

[a] Pucca housing consists of permanent structures constructed of concrete and bricks.
[b] Households with electricity include both legal and illegal connections.
Source: ORG Survey, 1996 and ORG background papers for this report.

1.19 Finally, Himachal Pradesh and Punjab have, by far, the highest level of electricity connection (96% and 94%, respectively). In Andhra Pradesh and Maharashtra, about two-thirds of households have electricity connections. Rajasthan and West Bengal lag behind the others (33% and 22%, respectively). The low rate of connection in Rajasthan is caused primarily by the scattered population. In the case of West Bengal, low income levels may be the main cause. The vast differences among the states surveyed are typical of India's many differences, and help provide a balanced view of the country's rural energy use.

Organization of This Report

1.20 This report begins by providing an overview of India's rural energy use by function (cooking, water heating, space heating, preparation of cattle feed, industrial application, irrigation, and farm motive power). Trends in rural energy use over time are then identified, taking advantage of an earlier survey. Next, several aspects of social equity are reviewed in relation to rural energy, followed by an examination of rural energy markets within their current policy framework. Finally, policies are recommended, based on the study's findings.

2

Patterns of Rural Energy Use

2.1 Changes in the way rural people in India use energy have been slow, especially when compared to the rapid changes occurring in urban areas. Rural households, even prosperous ones, continue to depend on traditional fuels to meet most of their energy requirements, supplemented by small amounts of kerosene and electricity for lighting (Cecelski, Dunkerley, and Ramsay 1979). With some exceptions—notably Punjab—energy use in agriculture, artisan activities, and transportation is still largely provided by human and animal labor.

2.2 Nonetheless, some significant changes, even rapid ones, have occurred (Barnes and Floor 1996). The electrification of pumpsets for irrigation has expanded rapidly. Introduction of LPG in areas threatened by severe deforestation has made greater penetrations than expected. Expansion of electricity availability has made possible the greater adoption of appliances in rural areas, including such items as television sets and fans. Despite such successes, progress has been uneven.

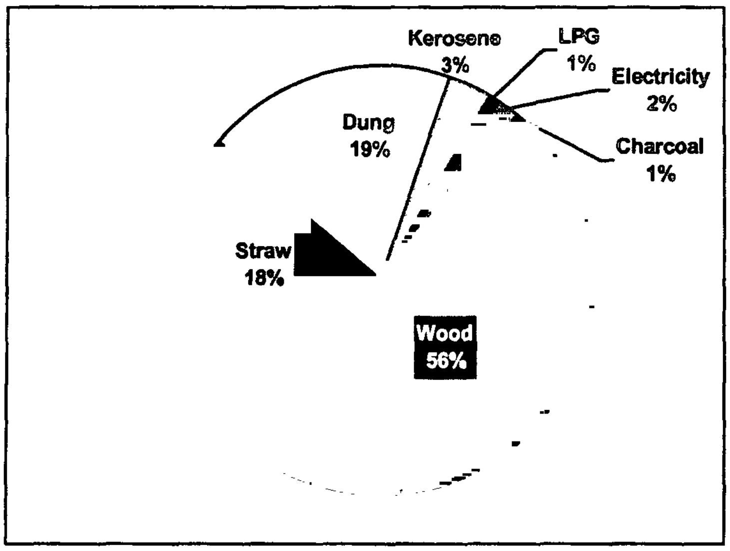
2.3 This study highlights several key problems. First, indoor cooking with biomass fuels in unventilated rooms is now recognized as a major health problem, especially for rural women. Second, the pricing of electricity service for rural areas has caused the industry financial problems, which has led to poor rural service. Third, the policy of providing kerosene at subsidized prices for lighting is fast becoming outmoded because electricity, which provides far superior household lighting, is now available in nearly all villages.

2.4 The following sections profile the main types of rural energy used in the six states included in this study. Most of the figures presented are fairly representative of the six states (for methodology, see Appendix), although the wealthier and poorer regions are slightly over-represented.

Types of Rural Energy and Energy-using Activities

2.5 Although the energy used by households in rural India is changing, traditional fuels, such as fuelwood, crop residues, and dung, are still the main sources of household cooking energy. Because cooking requires the largest amount of household energy, traditional fuels dominate the aggregate energy consumption for typical rural households. As indicated in Figure 2.1, traditional fuels account for more than 90% of total energy use. Kerosene and electricity are reserved for such purposes as lighting, cooling, and other non-cooking uses. However, traditional fuels dominate overall share of rural energy use.

Figure 2.1 Energy Use in Six States of India, 1996



Source: ORG Household Survey, 1996.

2.6 In India, rural households are likely to consume about twice as much energy as poor urban households. The reasons for this apparent anomaly are that rural households use low-density forms of energy in thermally inefficient devices, and they generally collect, rather than pay for, their fuel. Per person, rural household energy consumption varies considerably. Four states—Andhra Pradesh, Maharashtra, Punjab, and West Bengal—consume similar levels per capita, but households in the other two states—Himachal Pradesh and Rajasthan—use 50% more.

Profile of Cooking and Heating Energy Used in Rural Households

2.7 Energy is used in Indian rural households for cooking, water heating, space heating or cooling, cattle-feed preparation, and lighting. Cooking and lighting are essential activities in all the regions surveyed, while the importance of other functions vary by region. Although these household activities are distinguished and an effort has been made to assign energy consumption to each category, in many situations, they overlap. For example, water heating and space heating are often extensions of cooking.

2.8 By far, the main energy-using household activity in all six states is cooking, which accounts for 55-97% of all household energy used (Table 2.1). In all of these states, traditional fuels—fuelwood, crop residues, and dung—provide nearly all energy, while commercial fuel use for cooking is limited. Kerosene, for example, is used mainly as a firelighter to aid in the combustion of fuelwood. With the exception of Himachal Pradesh, LPG is used for cooking only among higher-income families. However, the retailing of LPG has typically been limited to urban areas of India, and is difficult to obtain in rural areas. The one exception is Himachal Pradesh, where LPG use is more widespread because of policies to subsidize it in order to preserve the forests. Today, this fuel is reported to be slowly gaining acceptance in other states because of improved availability and convenience.

Table 2.1 Annual Consumption of Energy for Domestic Activities
(per person in KgOE)

Type of energy use	*Andhra Pradesh*	*Himachal Pradesh*	*Maha-rashtra*	*Punjab*	*Rajasthan*	*West Bengal*
Cooking	136.2	251.2	154.7	193.9	286.6	212
Water heating	57.6	67.7	95.4	48.6	38.1	18.8
Space heating	6.4	47.2	26.9	14.7	19.2	neg.
Feed preparation (per animal)	4	15.7	neg.	13.2	44.7	neg.
Domestic lighting	12.3	11.6	7.8	7.0	6.6	11.6
Total	216.5	393.4	286.8	277.4	395.2	252.6

Note: Totals may not equal the sum of the individual uses because these figures are averages for the samples within the states.
Source: ORG Household Survey, 1996.

2.9 Fuelwood is the fuel of choice in rural areas, as it is compact, easy to light, long-lasting, and produces an intense but steady heat. But the share of fuelwood, crop residues, and dung in total cooking fuels depends largely on their availability and cost in terms of time required for collection, and in some instances, money. Fuelwood is widely used when forest resources are easily accessible, as is the case in Himachal Pradesh and Maharashtra. Dung is widely used in Rajasthan, where animal husbandry is an important occupation, and in Punjab, where dairy farming is practiced. Dairy cattle are kept in stalls, which means that dung is accumulated easily at central points.

2.10 Crop residues are used in areas of intensive agriculture typical of West Bengal, where particularly favorable wastes, such as those from cotton, are available. In some respects, crop residues might be considered the least satisfactory form of energy, as they burn quickly and are the most difficult to control. As such, it might be expected that mainly the poor would use them. However, in Punjab and Rajasthan, the percentage of households using crop wastes for cooking is often higher among large farmers, who have supplies readily available from their own lands. Easy access and availability apparently more than compensate for the fuel's poor burning characteristics.

Traditional Stoves and Indoor Air Pollution

2.11 In India, the most commonly used stove for cooking is the traditional chulha (Table 2.2). This stove has no chimney, and consists of stones plastered with mud to form a rough cube that is one-foot square, with one side left open to feed fuel. Smoke from the stove goes directly into the room. While primarily designed for fuelwood, the chulha has been adapted to burn charcoal and dung in some areas. Households often own more than one chulha, and even those that cook with LPG or kerosene use it.

2.12 The main problems associated with the traditional chulha are its inability to vent smoke out of a room, which causes significant levels of indoor air pollution, and its low efficiency (Parikh and Laxmi 2001; Parikh, Smith, and Laxmi 1999). Recent studies have shown that indoor air pollution, caused mainly by the burning of traditional fuels in unventilated stoves, is a significant problem in India. The effects on human health may be as high as 400,000-550,000 premature deaths per year (Smith 2000). The low efficiency of the traditional chulha has given rise to extensive programs to improve the stove's efficiency and disseminate improved models. Although such programs have met with some success, the traditional chulha still predominates in rural India.

Table 2.2 Ownership of Cooking Stoves, by State
(no. per 100 households)

Type of cooking stove	*Andhra Pradesh*	*Himachal Pradesh*	*Maha-Rashtra*	*Punjab*	*Rajasthan*	*West Bengal*
Wood						
Traditional chulha	114	84	124	111	125	146
Improved chulha (fixed)	6	19	6.5	10	10	2
Improved chulha (portable)	0.3	4	-	0.2	-	-
Sigri	1	2	3	2	1	-
Improved kerosene stove	18	12	26	4	7	24
Solar cooker	-	2	-	1	-	-
Biogas stove	1	0.4	1	2.3	-	4
LPG stove	4	45	2	13	1	1
Pressure cooker	3	105	-	60	4	10

Source: ORG Household Survey, 1996.

2.13 Another popular stove in rural India is the improved-efficiency kerosene stove. Mainly wealthier households use LPG. In many areas, pressure cookers have been adopted in recent years. In Himachal Pradesh, subsidized pressure cookers are part of a larger program to reduce fuelwood use. These stoves also reduce indoor air pollution.

Superiority of Electric Lighting over Kerosene

2.14 A generation ago, kerosene lanterns or oil lamps of various sorts provided much of the lighting in Indian villages. Thanks to the rapid spread of rural electrification, most villages are now served by electricity. In Andhra Pradesh, Himachal Pradesh, Maharashtra, and Punjab, virtually all villages now have electricity. Rates of rural electrification are lower in Rajasthan because of the vast area to be covered and dispersion of households, as well as in West Bengal, a low-income state. However, as Table 2.3 shows, not all households in electrified villages are connected. Only 23% are connected in West Bengal, 34% in Rajasthan, and about 64% in Andhra Pradesh. Himachal Pradesh and Punjab are the exceptions, where virtually all households are connected. In most cases, electrified homes are of pucca construction.

Table 2.3 Electricity Connections and Use

Annual income, connection, and consumption	*Andhra Pradesh*	*Himachal Pradesh*	*Maha-rashtra*	*Punjab*	*Rajasthan*	*West Bengal*
Annual household income (Rs.)	17,322	40,724	24,236	41,149	34,551	20,427
Villages connected, 1994 (%)	100	100	100	100	84	76
Households connected, 1996 (%)	64	96	65	94	34	23
Annual consumption of electricity per farmer (kWh/month)	272	na	237	328	16	46
Annual consumption of electricity per household (kWh/month)	13	48	27	77	10	12

Source: ORG Household Survey, 1996.

2.15 Although rural residents widely recognize the superiority of electric lighting over kerosene lamps, virtually all households with electricity use kerosene for lighting. This dual lighting system is illustrated in the pattern of energy used in lighting (Table 2.4). In terms of the amount of energy used for lighting, electricity and kerosene use vary significantly among states. In Andhra Pradesh, Himachal Pradesh, and Maharashtra, electricity and kerosene provide lighting based on equivalent amounts of energy. In Rajasthan and West Bengal, kerosene still dominates the lighting market. However, in terms of kilolumen (klm) hours, electricity provides as much as 100-200 times lighting per unit of energy compared to kerosene. This means both greater quality and greater quantities of illumination for rural households that have electricity.

Table 2.4 Energy Used in Lighting
(per-capita annual consumption)

State	*Electricity (KgOE)*	*Kerosene (KgOE)*	*Total (KgOE)*	*Electricity (klm hrs.)*	*Kerosene (klm hrs.)*	*Total (klm hrs.)*
Andhra Pradesh	6.3	6.0	12.3	907.2	14.2	921.4
Himachal Pradesh	8.3	6.4	14.7	1195.2	15.1	1210.3
Maharashtra	3.1	4.7	7.8	446.4	11.1	457.5
Punjab	5.1	1.9	6.0	734.4	4.5	738.9
Rajasthan	1.3	5.4	6.7	187.2	12.7	200.0
West Bengal	1.6	10.0	11.6	230.4	23.7	254.1

Source: ORG Household Survey, 1996.

2.16 The main reason for the continued reliance on kerosene is that electricity supplies are erratic, making it necessary to maintain a backup system. In addition, for lower-income households, kerosene is still attractive, despite its inferior lighting qualities, because it avoids the high installation cost of electricity service and the recurrent costs of bulbs. Finally, rural areas require mobile lighting at nighttime, which is served by kerosene lamps, as well as wick lamps and flashlights.

2.17 Given the significant capital costs incurred in extending electricity to rural areas and the vast superiority of electric lighting over kerosene lamps, the subsidy for kerosene lighting is now an outmoded concept. However, the poor quality of reliable electricity service, combined with the lighting needs of rural areas, makes the phasing out of the kerosene subsidy problematic.

Energy-use Differences by Artisan Activity and Village Industry

2.18 Artisan activities and small industries are an integral part of village life. In past times, many villagers practiced a wide range of artisan activities and agro-industries, catering to the everyday requirements of village populations. Over the past decade, however, these activities have gradually begun to disappear. Rising levels of education and expectations, as well as increased competition from cheaper factory-made goods, are reducing the role of local artisans, who now concentrate on providing services, rather than products, to local populations. In some cases, however, artisans have addressed this problem by clustering together in a single village to exercise collective power in procuring raw materials and to command a wider market. Partly as a consequence of this trend, their energy-use patterns have changed significantly over the years. While artisans still rely on traditional forms of energy, village industries have turned to both diesel and electricity for motive power.

2.19 The most common forms of artisan occupations are tailor, carpenter, barber, blacksmith, goldsmith, and potter. Primarily performed by low-income households, especially scheduled castes, these occupations are handed down from one generation to another. Many artisan and village industries depend largely on manual and animal labor for a large part of their energy use (see Table 2.5). Oil milling, for example, uses only manual labor. Traditional fuels represent a significant part of energy supplies in a limited number of occupations, including carpenter, potter, and weaver. Coal and charcoal are major forms of energy for blacksmiths and goldsmiths, where high, controlled temperatures are needed.

2.20 Since the most energy-intensive activities are goldsmithing and blacksmithing, baking in kilns (whether for pottery or bricks), and stone-crushing, these are the areas of greatest interest for energy conservation. In many cases, energy is used in a primitive, thermally inefficient way. Brickmaking, for example, involves stacking materials and fuel. The stacked pile is then covered with mud with a small opening made at ground level for starting the fire and ensuring a supply of oxygen, and a few holes made at the top of the heap to allow smoke to escape. The baking process lasts for two or three days.

2.21 Major rural industries, such as flour and rice milling, are agriculture based. In addition, brick-kiln and stone-crushing operations are common. Electricity is a major form of energy for flour and rice milling. Diesel is used mainly as a backup to electricity. Many industrial operators and some artisans are aware of energy-efficiency possibilities, but most consider them too expensive to implement.

Table 2.5 Energy Consumed by Artisans and Rural Industries Surveyed
(per unit per year in KgOE)

Activity type	Total energy (KgOE/yr)	Energy type (% of total)						
		Animate Energy	*Electricity**	*Diesel*	*Coal*	*Fuel-wood*	*Agri-waste*	*Other*
Artisanal occupation								
Carpenter	184.8	46.0	1.0	-	17.5	26.8	1.2	7.5
Tailor	187.2	21.8	6.2	-	25.9	0.4	-	35.7
Blacksmith	897.6	7.2	0.2	1.4	82.2	6.3	0.8	1.9
Goldsmith	254.4	24.9	1.3	-	66.4	-	1.4	6.1
Potter	1,339.2	5.7	-	-	10.2	41.1	23.5	15.9
Basketmaker	84.0	71.6	-	-	-	-	-	28.4
Weaver	256.8	33.5	-	-	-	46.1	-	19.6
Craftsmaker	72.0	100.0	-	-	-	-	-	-
Cobbler	73.2	75.0	-	-	-	-	-	15.0
Barber	70.8	86.2	3.0	-	-	-	-	10.9
Rural industrial units								
Flour mill	451.2	14.9	79.7	4.9	-	-	0.5	-
Oil mill	604.8	100.0	-	-	-	-	-	-
Rice mill	488.4	17.1	71.3	-	-	-	-	11.6
Brick mill	607.2	14.3	64.9	18.3	-	-	-	2.5
Stone-crushing units	3,218.4	32.2	1.2	-	40.4	11.2	7.7	7.3
Other	1,113.6	11.8	16.9	40.0	2.8	-	6.3	22.1

* Figures for electricity are for delivered energy.
Source: ORG Household Survey, 1996.

Importance of Pump Irrigation for Improving Agriculture

2.22 During the last 30 years, irrigation has played an increasing role in improving agricultural production. Ever since the advent of the Green Revolution in the 1960s—with the dominant role of new seeds, fertilizer and water—irrigation has been a key component of agricultural development. Irrigation not only provides for higher crop yields on existing land, but makes it possible to grow as many as three crops on some lands during a single year (Barnes and Binswanger 1986). A recent study on the long-term effect of rural electrification in Madhya Pradesh and Uttar Pradesh indicates that significant gains have been made in agricultural production and farm income because of irrigation pumping (Ranganathan and Ramanayya 1998.

2.23 The attractiveness of irrigation for improving farm productivity is evident from Figure 2.2. Between 1970 and 1992, the number of pumpsets in India grew by a factor of six, reaching more than nine million electric pumps by 1992. Although this growth was partially fueled by the large subsidies flowing into agricultural pumping, the number of diesel pumpsets and irrigation by canal also grew during this period. The six states surveyed varied significantly in the amount of land irrigated, but all had over 25% of their cultivated land irrigated (Table 2.6).

Canals have been the most common source of irrigation, followed by both electricity and diesel pumpsets. In recent years, traditional forms of irrigation have become somewhat obsolete for Indian agriculture.

Figure 2.2 Growth of Electric and Diesel Pumpsets for Irrigation, India 1970-1992

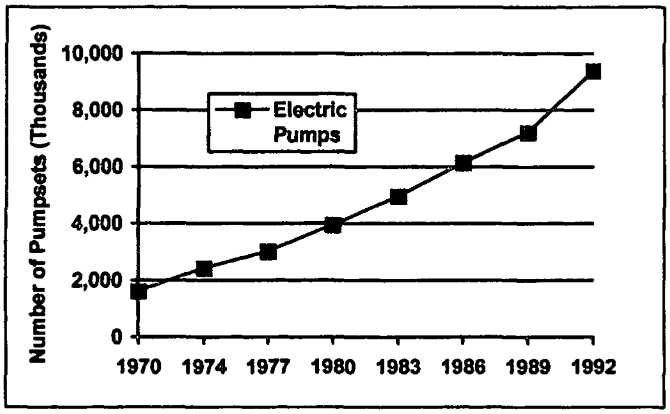


Table 2.6 Land Use, Irrigation Status, and Pump Use in Six States, India, 1996

Type of land use, irrigation source, and pump use	*Andhra Pradesh*	*Maha-rashtra*	*Rajas-than*	*Punjab*	*Hima-chal Pradesh*	*West Bengal*	*Aggregate*
% agricultural land cultivated	94	91	97.5	98.8	98.9	98.1	96.1
% cultivated land irrigated	41	26.6	27	99.7	35.4	52	36.3
% irrigation by source							
Canal	74	26.4	60.4	1.4	76.1	48.6	42.3
Electric pumpset	20.8	67.8	11.8	60.9	-	2.5	33
Diesel pumpset	4.4	4.3	24.9	32.6	3.3	31.4	19.4
Other	0.8	1.5	2.9	5.1	20.6	17.5	5.3
% farmers with pumps							
All pumps	23	13	6	83	1	13	19
Electric pumps	22	10	1	60	0	6	14
Diesel pumps	1	2	6	52	1	7	8

Source: ORG Household Survey, 1996.

2.24 The importance of irrigation is underscored by the percentage of land now irrigated for the six states, which varies from 25% of cultivated land to nearly 100%. In Punjab, virtually all cultivated land is under some type of irrigation, with most irrigated either by diesel or electric pumpsets. About 20% of farmers in the states surveyed have electric or diesel pumps. There is a significant amount of regional variation because of differences in level of development, infrastructure, and water-resource conditions. Canal irrigation is also important, accounting for the majority of irrigation in Andhra Pradesh and Rajasthan.

Electric Versus Diesel Pumps

2.25 Deciding whether to use diesel fuel or electricity for agricultural pumping depends upon a variety of factors. Electricity for agricultural pumping involves significant subsidies from state utilities, so, as might be expected, use of electricity is more prevalent than diesel. However, diesel is still used in many states. In the agriculturally advanced Punjab, for example, more than half of farmers own both diesel and electric pumpsets. In areas where availability is not so widespread, such as Rajasthan and West Bengal, farmers use diesel rather than electric pumps for irrigation (Tables 2.7 and 2.8).

Table 2.7 Electricity Used for Agriculture in Six States, 1996

Profile of farmers with electric pumps	*Maha-rashtra*	*Andhra Pradesh*	*West Bengal*	*Punjab*	*Himachal Pradesh*	*Rajasthan*	*Avg.*
Electric pump use (% of farmers)	22	10	1	60	0	6	14
Avgerage electric-pump capacity (horse power)	5.1	4.8	5	5.2	na	4.1	5.1
Electric consumption (kWh/yr)	3,563	4,495	6,117	5,715	na	1,939	4,579
Expenditure (Rs./yr)	2,009	1,976	2,475	3,159	na	1,183	2,491
Average price (Rs./kWh)	1.09	0.88	0.32	0.70	na	1.01	0.89
Hours of pumpset use per day							
Summer	4.0	4.7	5	6.9	na	0.2	4.9
Monsoon	0.7	4.5	4.3	3.0	na	0	1.9
Winter	4.4	4.3	4.3	6.2	na	1.8	4.9

Note: Consumption and expenditure figures are based on recall answers by farmers, who were asked such questions as, "What is the average number of hours the pump is used per day?" From their responses and based on the pump size, electricity consumption was estimated for each farmer with a pumpset. Figures should be fairly reliable as they agree with a more recent assessment, based on metering of pumps (World Bank 2001a).

Kilowatt hours have not been adjusted for efficiency because this is the energy delivered to the pump. Figures are averages for users. The average price that the SEBs obtain from all consumer classes is estimated at about 50 paise per kWh because large farmers consume more and pay less than do smaller farmers.

Source: ORG Household Survey, 1996.

2.26 Electric pumps are responsible for much of the electricity consumed in the rural areas of India. For the total farmer sample covering 406 farmers with electric pumps, the average electricity consumption per pumpset is close to 400 kWh per month (compared to the typical residential consumption of 20 kWh or less). This expenditure for electricity is about Rs.200 per month, and is based on a yearly fixed charge based on pump capacity. As a consequence, the average price of electricity can be estimated at approximately Rs.0.89 per kWh. This is higher than the figures estimated by the SEBs, but is still low compared to the price paid by other sectors in India.[4]

Table 2.8 Diesel Used for Agriculture in Six States, 1996

Profile of farmers with diesel	*Maha-rashtra*	*Andhra Pradesh*	*West Bengal*	*Punjab*	*Himachal Pradesh*	*Rajasthan*	*Avg.*
Agricultural uses							
% farmers using diesel	3.7	3.9	7.0	60.8	1.3	10.4	10.2
Annual consumption of users (l)	2352	664	1309	2047	1567	2143	1958
Annual expenditure of users (Rs.)	19,639	5,179	9,660	14,344	11,036	16,277	14,340
% use by type							
Irrigation	44	48	100	56	44	73	61.
Agriculture	18	28	0	34	22	18	26
Transport	37	6	0	8	32	5	10
Other	0.4	19	0	2	2	3	3
Farmers with diesel pumps							
% farmers using diesel pumps	1.3	2.1	5.6	52.1	0.6	7.2	7.6
Avg. diesel pump capacity (horsepower)	5.0	4.6	5.2	7.0	8.0	7.3	6.3
Distance from where purchased	23	6	12	8	9	13	10
Annual consumption of owners (l)	1,126	707	1,344	1,226	120	2,171	1,277
Annual consumption (equivalent kWh)*	9,906	6,046	13,135	10,907	11,720	19,440	11,475
Annual expenditure (Rs.)	10,062	5,571	10,142	8,608	8,300	19,263	9,477
Price of diesel per equivalent kilowatt hour (Rs./kWh)	2.52	2.43	2.26	2.15	2.15	2.45	2.22

* For diesel, annual consumption is reported in equivalent kilowatt hours, meaning that the efficiency of the diesel engine has been taken into account.
Source: ORG Household Survey, 1996.

2.27 For farmers in rural India, the alternative to using electricity is diesel. Many farmers use diesel fuel, although the frequency of use varies significantly by state. The figures in Table 2.8 cover all forms of diesel use, including pumping, tractors, and other agricultural equipment. For the farmers who use diesel fuel, consumption is high. They consume close to 2 tons of diesel fuel annually, at a cost of more than Rs.14,000. Just over one-half of this amount is used for agricultural pumping, while the rest is used for other agricultural activities, including transport, tractors, and threshing.

[4] The price of electricity varies by sector. In 1994, the price for commerce and industry was more than Rs. 2 per kWh and Rs. 0.9-1.3 per kWh for residential use. Estimates by some SEBs are as low as Rs. 0.25 per kWh, which appears inaccurate, according to this study.

Willingness To Pay and Poor Electricity Reliability and Service

2.28 Farmers generally prefer electricity over its alternatives for reasons of convenience and price. In regions where electricity is available, they are more likely to adopt electricity over diesel to meet irrigation needs. Diesel is used for irrigation in states where electricity has not penetrated as deeply into rural areas, such as Rajasthan and West Bengal.

2.29 The fact that many farmers use diesel for agricultural pumping indicates they are willing to pay for irrigation services, even at higher prices. Of the farmers surveyed, located mainly in Punjab, Rajasthan, and West Bengal, nearly 8% are willing and able to pay for irrigation services at prices that are much higher than electricity, without considering the greater maintenance and capital equipment expenses. The reasons for using diesel might include the unavailability and unreliability of electricity supply, along with several other factors. In India, the price of diesel is slightly below its world market price, but the diesel subsidy is not as significant as that for electricity. Farmers who use diesel for pumping consume more than 1,000 l per year at a cost of more than Rs.9,000. Adjusting for the efficiency of pumps, this totals well over Rs.2 per kWh of energy compared to much less than Rs.1 per kWh for electricity users.

2.30 The survey clearly demonstrates the problems of the electricity power supply. Although farmers in rural areas pay well below the cost of service, they receive low-quality service. In most of the six states surveyed, more than 80% of farmers with electric pumps characterize service as "irregular." Close to 50% experience daily power cuts of varying length, and the average number of power failures per month is perceived at about 30 (one per day) (Table 2.9).

2.31 The pricing of electricity for agriculture is misunderstood by farmers. When asked to identify whether the highly subsidized electricity they were receiving was taxed or subsidized, only 20% of the farmers interviewed indicated that they knew the electricity used for agricultural pumping was subsidized; more than 50% indicated that they did not know; and close to 14% believed it was taxed. This misunderstanding highlights the poor communication between the SEBs and the public concerning critical policy issues. In this case, farmers were receiving a subsidy of close to Rs.1 or more per kWh, amounting to thousands of rupees over the course of a year, but most were unaware of it.

Table 2.9 Farmers' Perception of Electricity Service, 1996

Farmer perception	*Maha-rashtra*	*Andhra Pradesh*	*West Bengal*	*Punjab*	*Rajasthan*	*Average*
Sample farmers with electric pump	172	40	3	159	32	406
Average no. of times electricity failed per month	37	75	37	12	94	32
Supply status (% of users)						
Most irregular	37	34	0	24	0	30
Irregular	43	51	0	54	41	48
Normal	19	14	100	21	58	21
Power cut status (% of users)						
Daily/weekly	75	82	0	71	27	70
Rarely/never	18	12	66	18	10	18
No response	5	5	33	8	62	11

Note: Himachal Pradesh is not included because the number of farmers with pumps was extremely low.
Source: ORG Household Survey, 1996

2.32 Farmers are discouraged by these outages, caused in part by the low prices they pay for electricity. In the survey, they indicated a potential willingness to pay more for better electricity service. This is confirmed by the fact that many farmers are paying more for agricultural pumping with diesel pumps—as much as two-to-three times the amount they pay for electricity service. Also, as indicated in Table 2.10, just less than 50% of the farmers surveyed in the study agreed with the statement, "I would be willing to pay more for electricity if there were fewer power cuts or dimming." Unfortunately, evidence from focus group interviews indicates that there is rampant distrust between farmers and the SEBs. Many farmers would be willing to pay more for better service, but they suspect that, as prices rise, service will not improve. This is the dilemma faced by electricity reform in India.

Table 2.10 Farmers' Perception of Energy, 1996

Farmer perception	*Maha-rashtra*	*Andhra Pradesh*	*West Bengal*	*Punjab*	*Himachal Pradesh*	*Rajasthan*	*Average*
Electricity is:							
Taxed	18	20	20	37	6	6	14
Subsidized	7	11	7	32	4	53	20
Neither taxed nor subsidized	27	4	15	18	3	3	13
Do not know	48	65	58	13	86	39	54
"I would be willing to pay more for electricity if there were fewer power cuts or dimming."							
Agree	34	50	41	62	56	51	47
Disagree	37	25	41	9	18	31	29
No response/no opinion	29	25	18	29	2,651	18	24

Source: ORG Household Survey, 1996.

Conclusion

2.33 Traditional fuels account for most rural energy use, including many forms of cooking and heating. Women do most of the cooking, using traditional stoves. Improved stoves are seldom used, which may have important implications for overuse of local natural resources and the health of women and children. Electricity use, in rural households and on the farm, is growing. Several key issues concerning rural-use patterns emerged from the study. Electricity supply is unreliable; daily power outages can lead to reduced benefits for both households and farmers. While rural residents appear ready to pay more for electricity service if power outages can be reduced, significant barriers to increasing prices, stemming from distrust between consumers and electricity distributors (according to focus-group interviews), remain. Despite these problems, electricity is having a significant effect on changing farming patterns in rural India. The next chapter turns to the changes that have occurred in rural energy use.

3

Changes in Rural Energy Use

3.1 Rural energy use in India has been changing slowly. Households still depend largely on traditional fuels, which account for about 90% of total energy use. Except for households in Himachal Pradesh, the decision to switch fuels over the past five years has occurred in only about 10% of the households surveyed. Continued reliance on traditional fuels in rural areas contrasts sharply with poor urban households, the group that should most closely correspond to the majority of rural residents. Twenty years ago, the urban poor also depended heavily on such traditional fuels as fuelwood and crop residues for their cooking energy. However, because of the liberalization of commercial fuel markets, they now use kerosene and LPG. The switch to modern cooking fuels has not occurred in rural areas, where traditional fuels predominate in households across all income levels.

3.2 Despite their cumbersome nature, thermal inefficiency, and poor burning characteristics, traditional fuels persist because they are freely available to most rural households. Availability is also the most important factor in determining which traditional fuel to use. In the high-income Punjab, for example, dung, rather than fuelwood, is the most important traditional fuel because cattle in that state, largely penned, make dung easier to collect. In that state, crop residues are also widely used, even among higher-income farmers who could afford higher-value fuels. Indeed, the use of crop residues rises, rather than falls, with the size of landholding. This raises the issue of whether rural people are moving up or down the energy ladder.

Up or Down the Energy Ladder?

3.3 Although traditional fuels still predominate in rural areas, the pattern of their use is changing, as evidenced by a significant trend to move away from fuelwood, despite its popularity. Although it remains the most commonly used fuel in most states, crop residues and dung together now exceed fuelwood use in Punjab and West Bengal. Based on averages extrapolated from the six states surveyed, rough calculations indicate that, for India overall, about one-half of the energy used is in the form of fuelwood, one-fifth crop residues, and about one-tenth dung (Table 3.1).

3.4 People in rural areas are acutely aware of the changes occurring in household energy use. When household survey respondents were asked whether, during the past five years, they had switched fuels for cooking, about 10% reported that they had switched to another fuel, largely because of their inaccessibility to fuelwood and high cost of supplies, rather than the inconvenience of using fuelwood for cooking (Table 3.2).

Table 3.1 Energy Use in the Six States Surveyed, by Fuel Type
(KgOE per capita per month)

Fuel type	*Maha-rashtra*	*Andhra Pradesh*	*West Bengal*	*Punjab*	*Himachal Pradesh*	*Rajasthan*	*Average*
Fuelwood	18.8	10.8	7.1	8.6	29.0	19.7	26.6
Crop residue	10.8	5.4	10.6	5.4	0.2	3.6	4.9
Dung cake	4.0	1.2	5.1	14.3	0.6	8.8	5.2
Charcoal	0.1	0.1	1,8	0.1	0	0	0.39
Fossil coal	0	0	neg.	0	0	neg.	0
LPG	neg.	0.1	neg.	0.3	1.0	0.1	0.2
Biogas							
Kerosene	0.8	0.9	1.2	1.0	1.0	0.7	0.9
Electricity	0.4	0.3	0.2	1.2	0.8	0.1	0.5
Total	36.6	18.7	26.0	30.1	32.6	33.0	27.0

Table 3.2 Percent of Households That Switched Fuels in the Six States
(% of households)

	Maharashtra		*Andhra Pradesh.*		*West Bengal*		*Punjab*		*Himachal Pradesh*		*Rajasthan*	
Fuel type	*From*	*To*	*From*	*To*	*From*	*To*	*From*	*To*	*From*	*To*	*From*	*To*
Fuelwood	6.6	0.5	4	0.5	1.1	0.1	2.9	0.3	38.8	-	3.1	0.3
Crop residue	2	0.1	0.8	0.1	0.1	0.1	2.3	-	-	0.1		0.7
Dung cake	0.7		0.1	0.1	0.6	0.1	4.3	0.3	0.7	0.3	0.3	1.8
Kerosene	0.6	2.5	0.5	3.0	0.1		0.3	1.2	0.2	13.1	-	0.3
Charcoal	0.1	-	0.1	0.1	0.3	0.3	0.2	-	-	-	-	0.1
Fossil coal	-	-	0.2	0.1	0.2	0.1	-	-	-	0.1		
LPG		1.2	0.1	1.5	-	0.4	-	6.8		24.7		0.6
Biogas	0.4	3.6	-	0.4	-	1.1	-	1.1	-	2.4	-	-
Electricity	-	0.6	0.1	0.1	-	0.3	-	0.3	-	-	-	-
No change	91.5		94		97.5		90.0		59.2		96.2	

Source: ORG Household Survey, 1996.

3.5 Many households now purchase fuelwood. In Rajasthan, for example, households switched from fuelwood to crop residues and dung cake, which are usually recognized as inferior fuels. In other states, however, households switched from fuelwood to kerosene and LPG. In most states, only 3-4% of households reported a shift away from fuelwood. However, in Himachal Pradesh, nearly 40% of households reported switching from fuelwood to either kerosene or LPG.

3.6 A unique characteristic of this study is that, in four of the six states, 1980 and 1996 data are available for the same villages, which confirm the findings of the survey recall questions. Significant shifts in energy use occurred between 1980 and 1996, with fuelwood maintaining its dominant status, but losing ground to other fuels (Table 3.3). For instance, in Andhra Pradesh, Punjab, and West Bengal, the percentage of households using fuelwood declined 30-40% over this 16-year period. Once again, the switch seems to have been driven by local shortages, commercialization of fuelwood, and the greater availability of other fuels. In Andhra Pradesh, households switched from fuelwood to straw, while in Punjab, rural people shifted toward using more dung, kerosene, and LPG.

Table 3.3 Fuel Types Used by Rural Households In Four States
(% of households)

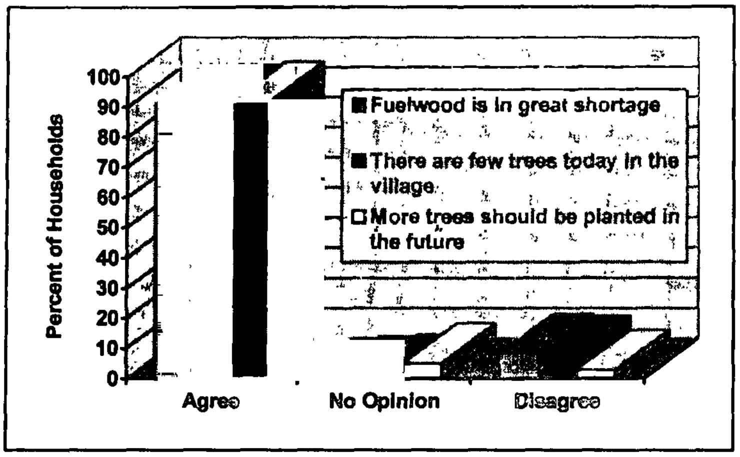
	Andhra Pradesh		*Maharashtra*		*Punjab*		*West Bengal*	
Fuel type	*1980*	*1996*	*1980*	*1996*	*1980*	*1996*	*1980*	*1996*
Fuelwood	94	60	93	95	83	48	82	47
Straw	17	49	39	37	50	36	57	50
Dung	44	33	71	78	72	83	87	91
Charcoal	0	1	2	1	1	0	1	13
Kerosene	98	98	94	100	81	80	81	96
LPG	0	8	0	3	0	13	0	2
Electricity	na	66	na	65	na	92	na	26
Biogas	0	0		9	0	2	0	0

Note: Percentages are limited to the 132 villages surveyed in 1980.

3.7 Rural people's perceptions regarding such trends in energy use mirror their increasing concern over fuelwood availability. As Figure 3.1 shows, nearly 90% of households agreed with the proposition that, at present, fuelwood scarcity will continue into the future. Andhra Pradesh and West Bengal reported fuelwood shortages on a statewide basis, although the extent of shortage varied by district. Maharashtra also reported decreasing availability over the past few years, as evidenced by the need to travel longer distances to obtain adequate supplies. Rajasthan, a state with low rainfall and modest forest cover, is experiencing heavy pressure. In Himachal Pradesh, a state well endowed with forest cover and tree resources, recent exploitation has reached a scale detrimental to the environment, especially in the colder districts where fuelwood is used extensively for space and water heating.

3.8 Feelings are mixed about using dung as a fuelwood alternative. About 25% of survey respondents indicated that use of dung depletes soil fertility. With regard to crop residues and dung, about half of village leaders believed that supplies had declined; the other 50% were of the opinion that no change had occurred or that supplies had even increased.

Figure 3.1. Household Perception Toward Fuelwood Supply in the Six States Surveyed, 1996

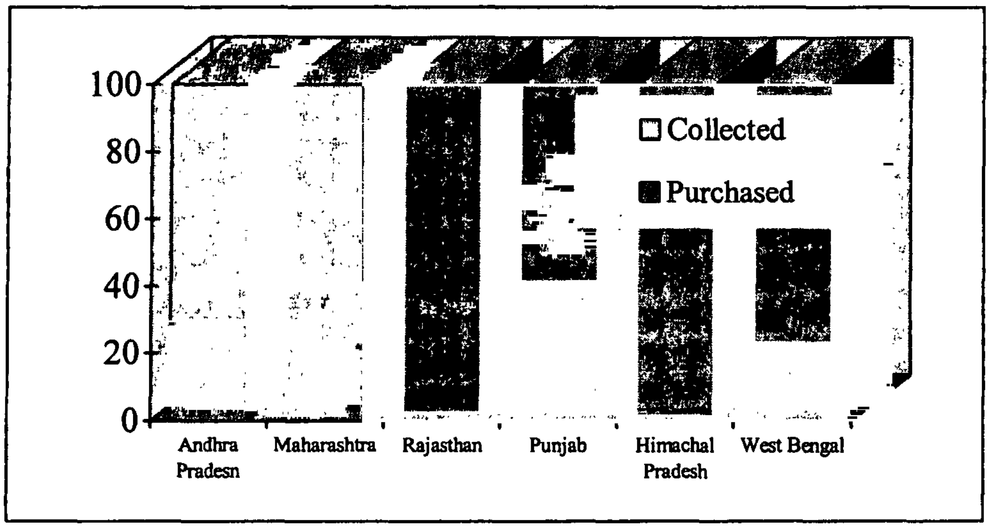


Source: ORG Household Survey, 1996.

3.9 The possibility of a rapid, large-scale trend toward commercial-fuel use in rural areas, as occurred in India's urban areas, does not appear imminent. Barring such major changes, rural households are likely to continue gathering and using fuels available from their local environments and relying on traditional fuels for a large portion of their domestic energy needs, even as their incomes rise. However, a possible source of change could arise through changes in supply conditions. As a result of the scarcity of fuelwood supplies, many rural residents are beginning to purchase fuelwood (see Figure 3.2).

3.10 Commercialization of fuelwood, and to a lesser extent, straw and dung, would eliminate one of their most attractive features—that they can be gathered without cash expenditures by rural households. Commercialization also enables comparisons between costs of traditional and other fuels. Adoption of pressure cookers in some areas, for example, indicates that rural householders are aware of and react to such comparisons. Because of the low thermal efficiency at which they are burned, traditional fuels can be more expensive to use than modern ones. In a study of household energy use in Hyderabad (ESMAP 1999), for example, fuelwood, kerosene, and LPG were adjusted to take into account the efficiencies with which they were used in cooking. Results showed that fuelwood was, by far, the most expensive cooking fuel (about Rs.18 per KgOE of useful energy, compared to about Rs.10 for both kerosene and LPG). In short, commercialization could stimulate the switch from traditional to commercial fuels that has been experienced in cities of developing countries, as well as in some rural areas (e.g., Davis 1998).

Figure 3.2 Percent of Collected and Purchased Fuelwood in India, 1996



3.11 A second stimulus to the energy transition might come through the broader process of modernization. As communications improve, rural populations become increasingly aware of innovations. For example, the experience of neighbors who have adopted new appliances, such as pressure cookers, can allay the initial hesitations of risk-adverse households. Also, young people may be unwilling to tolerate the older generation's traditional customs. The rapid domestic fuel transition in Hyderabad, for example, happened at a time of declining household incomes and rising prices of commercial fuels—two factors that would be expected to constrain the move from traditional to commercial fuels. The fact that the transition happened under such adverse economic circumstances testifies to the importance of other characteristics of modern fuels, such as cleanliness and ease of use.

Success of Rural Electrification

3.12 Although rural households in India continue to rely heavily upon traditional fuels, marked improvement has been made in the small, but significant supplies of commercial fuels to rural areas. Rural electrification programs have led to high levels of village connections (Table 3.4). The percentage of electrified households has increased significantly over the past 16 years. In the four states for which 1980 data were available, the percentage of households with electricity increased significantly between 1980 and 1996. Virtually all villages in the sample have electricity. But overall levels of household connections are being held back because of low incomes, high connection costs, poor-quality housing, and unreliable electricity supplies, meaning that a backup system, largely kerosene based, must be maintained. Future trends in household connections, and therefore electricity use, will depend on developments in these areas.

Table 3.4 Changes in Rural Electrification in Four States, 1980 and 1996

	Andhra Pradesh		*Maharashtra*		*Punjab*		*West Bengal*	
Income and connections	*1980*	*1996*	*1980*	*1996*	*1980*	*1996*	*1980*	*1996*
Annual household income (Rs.)*	7,160	17,322	8,089	24,236	7,128	41,149	9,979	20,427
Villages connected (%)	97	100	90	100	100	100	39	76
Households connected, 1996 (%)	11.7	63.9	14.3	65.4	47.5	94.3	4.7	22.9
Agricultural connections (mean/ village)	10	-	13	-	29	-	2	-

* Annual household income for 1980 was based on random selection of households, but should approximate the average for the villages surveyed.
Source: ORG Household Survey, 1996; Samanta and Sundaram, 1983.

3.13 The level of electricity consumption is closely correlated to levels of household income. States with the highest rural household-income levels have the highest levels of connections and consumption, and within states, connections and consumption are greatest in the higher-income homes. Though the initial use of electricity is for lighting, this is quickly followed by a growing range of electric appliances, including irons, radios, television sets, and fans (Table 3.5). Based on past and current experience, it can be stated that, as incomes rise, demand for electricity increases sharply, well above the increase in household income, which is assumed to occur as India continues its economic growth.

3.14 Tariffs also play a role in the level of electricity consumption. In Himachal Pradesh, for example, high consumption levels can be attributed to high incomes and low tariffs.

Table 3.5 Ownership of Selected Electric Appliances
(no. per 100 households)

Appliance	*Andhra Pradesh*	*Himachal Pradesh*	*Maharashtra*	*Punjab*	*Rajasthan*	*West Bengal*
Table fan	12	20	29	79	18	14
Ceiling fan	36	28	11	158	19	25
Transistor radio	11	22	18	7	33	44
Television set	14	57	17	68	7	13
Tape recorder	10	35	12	46	10	7
Refrigerator	1	4	1	26	-	-
Electric iron	9	58	19	59	10	4
Mixer/grinder	3	9	3	14	1	-
% households with electric appliances	64	96	65	94	34	23

Source: ORG Household Survey, 1996.

3.15 The percentage of rural households with electricity significantly affects the level of appliance use. As can be seen from Table 3.6, with the exception of battery-powered transistor radios, all forms of appliance ownership have increased in electrified households. It is well known that lights are the first item to be adopted by households that acquire electricity for the first time, so virtually all households have electric lights. However, there are some dramatic increases in acquisition of other appliances. For example, television sets, virtually unknown in rural villages in 1980, are now owned by nearly 50% of rural households. In India's hot climate, electric fans play an important role, and the number of people who own them has increased significantly. Even more surprising, nearly 10% of rural households own a refrigerator, and use of dessert coolers is on the rise in certain states.

Table 3.6 Changes in Appliance Ownership in Four States, 1980 and 1996
(% of electrified households)

Lighting and appliances	1980	1996
Electric light	100	100
Table fan	32	41
Ceiling fan	24	48
Transistor radio	47	31
Television set	1	40
Tape recorder/record player	3	26
Refrigerator	1	9
Dessert cooler	0	6
Iron*	23	32

* The 1980 figure covers electric and charcoal irons, while the 1996 figure covers electric irons.
Source: ORG Household Survey, 1996; Barnes 1988.

3.16 As indicated in Chapter 2, the high unreliability of electricity supplies to domestic and other consumers imposes major costs on rural consumers. Some 43% of survey respondents reported they would be willing to pay more for electricity if they were assured greater reliability of electricity supply (see Table 3.7). Appliances are damaged by the poor quality of the electricity received, and customers have to maintain a backup system. This is particularly noticeable in lighting, where virtually all electrified households also use kerosene lamps. Attention to improved reliability could not only save consumers money but, in such cases as lighting, reduce total energy consumption, as electric lighting is far more efficient than kerosene lamps. Energy consumption for lighting in Punjab is lower than in poorer states because most households use electricity.

Table 3.7 Willingness To Pay for Better Electricity Services
(% of households agreeing with statement)

Statement	*Maha-rashtra*	*Andhra Pradesh*	*West Bengal*	*Punjab*	*Himachal Pradesh*	*Rajas-than*
Electricity is expensive for lighting.	67	61	21	72	62	53
Electricity is more expensive than kerosene for lighting.	61	61	18	56	59	39
Electricity is not reliable for lighting.	56	46	24	54	32	45
I would be willing to pay more for electricity if there were few power cuts and dimming.	31	42	31	54	56	50
It is better to have agricultural pumpset meters, along with very reliable supply rather than fixed rates at current level of supply.	19	27	20	34	30	40
Improved chulha consumes less energy than the traditional chulha.	13	38	33	64	67	39
Use of improved chulha causes fewer respiratory diseases for women.	16	36	39	34	41	62

Source: ORG Household Survey, 1996.

3.17 Another interesting finding is that, despite the low use of improved stoves in rural areas, a high percentage (62%) of households perceive that these stoves can reduce respiratory diseases among women. This appears to be an even greater benefit than using less energy. Thus, there appears to be a good market for improved stoves, but with a greater emphasis on removing smoke from the household.

Slow Transition to Petroleum Fuels

3.18 In urban households that use traditional fuels, kerosene is the first step up the household energy ladder. Then, as household incomes rise, this transitional fuel is replaced by LPG and electricity (Barnes, Krutilla, and Hyde 2001). Kerosene's role as the initial commercial fuel in the energy transition owes much to the government-controlled public distribution system, whereby consumers have ration cards that cover a wide variety of products, including staple foods (such as rice) and kerosene. Ration cardholders purchase these products at highly subsidized prices from designated retailers called ration shops. In theory, kerosene in India previously was sold only through ration shops, so all other kerosene sold in the market was, strictly speaking, illegal. Despite this proscription, kerosene is widely available in towns, at least on the free or illegal market, though at a much higher price. Tighter controls have been attempted in rural areas, but without much success.

3.19 In rural India, kerosene's transitional role is less clear. Rural households have begun to switch from fuelwood to both kerosene and LPG (Table 3.8), but the percentage of households using such fuels is relatively small. Although rural households start using kerosene as their incomes rise, they also continue to use kerosene, even at higher income levels, as the functions served by kerosene (fire lighter, backup for electric lighting, and mobile source of lighting) are needed by all families, regardless of income. Per-capita consumption of kerosene in all states is similar, regardless of income level, suggesting that consumption is determined by the available rations. As such, kerosene consumption can be expected to rise with population growth and increases in rural incomes.

3.20 In urban India, LPG is now the fuel of choice for cooking and related household activities. While its superior characteristics have always been recognized, LPG was in short supply until quite recently (Thukral and Bhandari 1994). LPG was distributed through retail dealers associated with the national petroleum companies. The distribution companies had exclusive rights to sell the fuel, but at prices set and controlled by the government. The result was a level of demand that far exceeded supplies, leading to long waiting lists for connections and limitations on the number of LPG bottles per customer.

3.21 In recent years, LPG supplies have eased, and the LPG market has been opened to private retailers on the condition that they sell imported, not domestically produced, LPG. The price is still controlled, but at a higher level than government-controlled supplies. Private interests have also been allowed to produce LPG cylinders, whose shortage has been a perennial problem in increasing LPG supplies. At the same time, supplies to government-affiliated retailers have grown somewhat. As a result, LPG use in Indian cities has increased rapidly, and the fuel is now used across all income levels.

Table 3.8 Cooking-fuel Switches by Households in Rural India, 1980-1996

	Fuel switched to						
Fuel switched from	*Wood*	*Straw*	*Dung*	*Kerosene*	*LPG*	*Biogas*	*% of all households*
Fuelwood	na	1.3	3.2	25.6	35.8	10.2	8.4
Straw	0.2	na	0.4	1.3	1.7	0.9	0.5
Dung cake	0.6	0.2	na	1.3	4.6	2.0	1.0
Kerosene	0.6	-	-	na	2.6	0.7	0.5

Note: na = not applicable; switch to all other fuels is negligible.

3.22 The extent to which rural areas have benefited from improved LPG supplies is unclear. Consumption in all states covered by this survey is low, limited to high-income households. The one exception is Himachal Pradesh, where LPG consumption per capita is now higher than that of kerosene because of the program of subsidized supplies to counteract deforestation. Little is known about the effectiveness of this program in discouraging fuelwood use, but the challenge is enormous as fuelwood currently accounts for 92% of domestic energy consumption.

Low Penetration of Renewable Energy

3.23 Adoption levels for new and renewable energy devices are somewhat disappointing in rural India. Despite significant investments made in renewable energy programs, the level of penetration is poor. Perhaps, as with rural electrification, people will begin to adopt renewable energy as they become more familiar with its benefits. Presently, the challenges to its promotion remain great.

3.24 The renewable energy devices examined in this study involve a range of technologies (Table 3.9). After decades of promotion, the percentage of people who own biogas plants is low; of those who own them, only half were working at the time of the survey. However, these figures may be somewhat misleading because only farmers with a significant number of cows have the dung resources to operate a biogas plant; nevertheless, this limited market for such devices should be more clearly recognized.

3.25 The most successful renewable energy programs have involved the conservation of cooking energy, which, based on results from the attitude surveys, is clearly a concern for rural people. Programs that have involved electricity have been less successful. The improved chulha program also has experienced a significant degree of success compared to other renewable energy programs. In addition, adoption of pressure cookers, which save energy when cooking, has met with success, especially in Himachal Pradesh and Punjab—the two states with the highest level of development—where more than 60% of rural households have pressure cookers.

Table 3.9 Percent of Households That Own Rural Energy Devices, 1996

Device	*Maha-rashtra*	*Andhra Pradesh*	*West Bengal*	*Punjab*	*Himachal Pradesh*	*Rajas-than*
Individual biogas plant	7.6	0.8	4.9	2.5	0.4	-
Improved chulha	6.4	6.0	1.3	9.5	20.1	9.7
Solar cooker	0.3	-	-	0.8	2.4	-
PV domestic light	-	-	-	-	1.6	-
PV lantern	-	-	-	-	1.8	-
Biogas lighting	-	-	-	0.3	-	-
Solar water heater	-	-	-	-	0.1	-
Solar pump	-	-	-	-	-	-
Wind pump	-	-	-	-	-	-
Improved bullock cart	1.8	1.5	0.9	16.3	0.1	10.7
Pressure cooker	8.4	3.1	9.5	59.2	89.4	-

Source: ORG Household Survey, 1996.

3.26 Promotion of renewable energy technologies has suffered because such systems generally are unavailable in the marketplace (Table 3.10). In this regard, the households surveyed were asked whether other types of devices were available for purchase. Once again, improved chulhas, biogas systems, pressure cookers and, to a certain degree, improved bullock carts were available in rural areas. Nearly all of the other renewable energy systems were unavailable in the marketplace. This finding reflects, in part, a policy focused on promoting pilot renewable-energy systems, rather than concentrating on ways to promote commercialization of these technologies.

Table 3.10 Availability of Renewable Energy Devices in the Marketplace, 1996
(% of households for whom device is available)

Renewable energy device	*Maha-rashtra*	*Andhra Pradesh*	*West Bengal*	*Punjab*	*Himachal Pradesh*	*Rajas-than*
Individual biogas plant	12.2	45.1	33.1	30.0	17.9	16.6
Improved chulha	9.3	42.0	23.2	34.9	42.3	34.4
Solar cooker	2.8	9.8	10.0	7.7	34.8	19.9
PV domestic light	0.7	3.0	5.6	1.2	17.7	15.6
PV lantern	0.7	1.4	2.2	0.8	30.7	15.2
Biogas lighting	1.1	4.2	11.7	2.3	8.3	17.0
Solar water heater	0.8	3.0	2.9	1.1	15.8	14.5
Solar pump	0.7	2.6	2.5	0.8	5.4	13.3
Wind pump	0.9	4.4	3.1	1.5	3.9	14.0
Improved bullock cart	32.1	45.1	20.6	61.4	4.3	45.9
Pressure cooker	54.2	45.4	69.4	84.6	90.9	-

Source: ORG Household Survey, 1996.

3.27 The public's perception of renewable energy devices is affected by its lack of experience using them. According to the survey, people are unaware of the benefits of such technologies as photovoltaics (PV), solar cookers, and other renewable energy systems. The exceptions are biogas plants and improved chulhas, which are more widely available in rural areas (Table 3.11). In general, the renewable energy technologies are perceived to be cleaner than traditional cooking methods for those people who have experience with the technologies. In states that have a significant number of households with improved chulhas, stoves are perceived as being more efficient and causing fewer cases of respiratory illness among women. Clearly, concerns about inefficiency and indoor air pollution associated with traditional stoves are a major reason for adopting improved stoves or biogas systems.

3.28 Targeted promotion of renewable energy technologies has created a barrier to wider acceptance. While a targeted approach may lead to the dissemination of a particular number of technologies, it does not assist in developing the market conditions to sustain use over a wide range of conditions. In such cases, subsidies are being used to facilitate adoption of the technology by a small number of people. Unfortunately, the broader goal of developing markets is harmed by too many target-driven programs.

3.29 Some key behavioral issues must be addressed in developing markets for renewable energy systems. For instance, use of the solar cooker means cooking in the open, while in Andhra Pradesh, Maharashtra, and West Bengal, women generally prefer to cook indoors. Households have indicated that this adds to, rather than alleviates, their burden. The adoption of biogas requires either stall-feeding of animals or a system to collect wet dung during the common practice of open grazing. An even greater constraint is that households need to own a sufficient number of animals to sustain a digester, which is generally limited to wealthier households. However, such problems are surmountable if households desire to adopt and use such systems.

Table 3.11 Attitudes Toward Renewable Energy Devices in the Marketplace, 1996
(% of households agreeing with statement)

Statement	*Maha-rashtra*	*Andhra Pradesh*	*West Bengal*	*Punjab*	*Himachal Pradesh*	*Rajas-than*
Biogas is an efficient technology for cooking.	28	44	61	60	48	69
Biogas consumes less energy than the traditional chulha.	26	43	58	57	47	67
Biogas increases indoor air pollution.	9	9	7	19	18	14
Improved chulha is a very clean and efficient technology for cooking.	16	40	37	41	70	68
Improved chulha consumes less energy than the traditional chulha.	13	38	33	64	67	39
Use of improved chulha leads to fewer respiratory diseases for women.	16	36	39	34	41	62

Source: ORG Household Survey, 1996

3.30 The most successful implementation of renewable energy systems occurs when households must pay for them. During the Study on the Utilization of Biogas in India, undertaken by ORG, it was seen that the cost factor makes the household aware of the technology's value and thus exercise caution in order to obtain its maximum benefit. One problem with purchasing systems is that households require a significant outlay of cash, which excludes a large percentage of the rural population. The survey found that rural households were more receptive to purchasing systems on credit (Table 3.12); however, it should be noted that loans to rural consumers from the scheduled banks have occasionally been waived by politicians; rural consumers may expect the same practice to occur with renewable energy systems.

Table 3.12 Interest in Purchasing Renewable Energy Systems on Credit
(% of households)

Renewable energy system	*Maharashtra*	*Andhra Pradesh*	*West Bengal*	*Punjab*	*Himachal Pradesh*	*Rajasthan*
Individual biogas plant	41.5	26.1	36.2	14.2	11.5	74.7
Improved chulha	39.2	20.1	38.5	5.7	21.1	80.9
Solar cooker	69.0	11.2	15.3	2.5	32.9	10.0
PV domestic light	16.4	6.3	10.5	0.3	29.2	43.8
PV lantern	11.5	3.3	7.9	0.2	38.2	35.5
Biogas lighting	9.3	4.8	20.3	1.2	8.9	36.9
Solar water heater	11.0	3.9	39.1	0.3	18.0	26.8
Solar pump	7.9	2.9	3.8	0.2	6.7	24.2
Wind pump	3.2	2.9	4.0	0.2	6.0	27.2
Improved bullock cart	19.0	15.4	16.8	3.7	2.4	65.2
Pressure cooker	40.7	18.0	40.4	9.7	14.7	-

Source: ORG Household Survey, 1996.

Conclusion

3.31 Several major issues emerge from the study of trends in rural energy use in the six states surveyed. The first is a dual movement away from fuelwood toward commercial and lower-value fuels (such as dung and straw). People are concerned about traditional energy shortages, especially the declining availability of fuelwood. Rural households largely agree that fuelwood is scarce and that its future availability is in doubt. Consequently, fuelwood is beginning to be commercialized in rural areas, and people are moving down the energy ladder to straw and dung, and, in wealthier states, up the ladder to kerosene and LPG. Another trend is the significant increase in the rate of rural electrification over the past 20 years. Although the quality of service and the extent of household adoption are problematic, electricity is now available in most parts of rural India. It can also be observed that a slower transition is being made toward petroleum fuels among higher-income classes and states included in the survey. Finally, renewable energy systems have not taken hold to any great degree in rural areas. In fact, with the exception of biogas and improved stoves, most rural people are unaware of such systems. Clearly, much work is needed to promote the greater availability of renewable energy systems to service rural people.

3.32 Success of India's rural electrification program over the past 20 years has brought several problems with it. Subsidies for electricity—especially those for agriculture—have slowed the expansion of rural electrification (compared to similar countries, such as China) and have severely limited the SEBs' ability to provide high-quality service. In some states, people are experiencing more than three power outages per day. The result has been a lack of incentives for the SEBs to expand or improve service, along with development of a profound mistrust by rural people toward the electricity company. The survey clearly demonstrates that many people are ready to pay higher prices for better service. In addition, the barriers to further expanding service include developing technical solutions for substandard housing and perhaps innovative billing systems for collecting revenue.

3.33 Rural electrification in India confronts a number of barriers. The initial costs of connection are frequently viewed as a deterrent to prospective users. It may be possible, however, to restructure electricity tariffs to spread initial costs over a longer time frame. A second issue is poor-quality rural housing. With present technology, only houses of pucca construction are easily connected. The correlation between electricity connections and housing standards is striking. As it is unlikely that rural housing can be rapidly upgraded, other connection technologies will be needed. The national Kutir Jyoti program, which finances the supply of low cost, single-point electric connections to poorer households, is an interesting attempt to address this problem (Operations Research Group, 2000).

3.34 Persistence of poor electricity service in rural areas counteracts energy efficiency. Use of more efficient florescent lamps, for example, is limited because the voltage required to start them is often insufficient. In addition, farmers often run their electric pumps continually because they want to pump as much water as possible when electricity is available to them. Low electricity prices also make investments in more efficient agricultural pumping unprofitable for farmers. From a financial point of view, leaking foot valves and inappropriate pump sizing do not matter to them.

3.35 The past system of rationing petroleum products has also limited their distribution in rural areas. Although recent changes in import and petroleum distribution policies are expanding availability in rural areas, there is nonetheless a lag involved. Partly because of higher incomes and a policy that makes LPG available in the hilly regions, Himachal Pradesh has had the most significant growth in LPG use, while use has also expanded in Punjab. In most other states, however, kerosene distribution is limited to the amount available through ration shops. Given the increasing commercialization of fuelwood in rural areas, there would seem to be a better rural market for petroleum products.

3.36 The pace of adopting new and renewable energy systems is painfully slow, in part, because past programs pursued demonstration projects over market development. However, the slow pace also reflects the difficulties inherent in selling renewable energy to rural people. At present, systems are unavailable for purchase in rural areas, and, in many cases, people have never heard of them. However, those who are aware of them understand their benefits, such as reduced indoor air pollution and better services. Adoption of renewable energy technologies could improve if products were more readily available for purchase in rural areas and if credit were available to soften upfront system costs.

4

Social Equity Issues

4.1 Traditional fuels, such as collected fuelwood, straw, and dung, may dominate the total energy use of rural households in India, but commercial fuels, such as electricity, purchased fuelwood, LPG, and kerosene have the greatest effect on a household's cash energy expenditures. Overall, rural residents spend close to 5% of their income on energy, a significant proportion of which is used to purchase fuelwood. In addition to the fuels purchased with cash, families in rural India spend much time collecting fuelwood and other traditional fuels. For fuelwood alone, the average collection time is about 30 hours per month. This fact underscores the general perception that fuelwood in rural India is increasingly scarce, resulting in movements both up and down the energy ladder—higher-income households are purchasing fuelwood and modern fuels, while poorer households are switching to straw and dung.

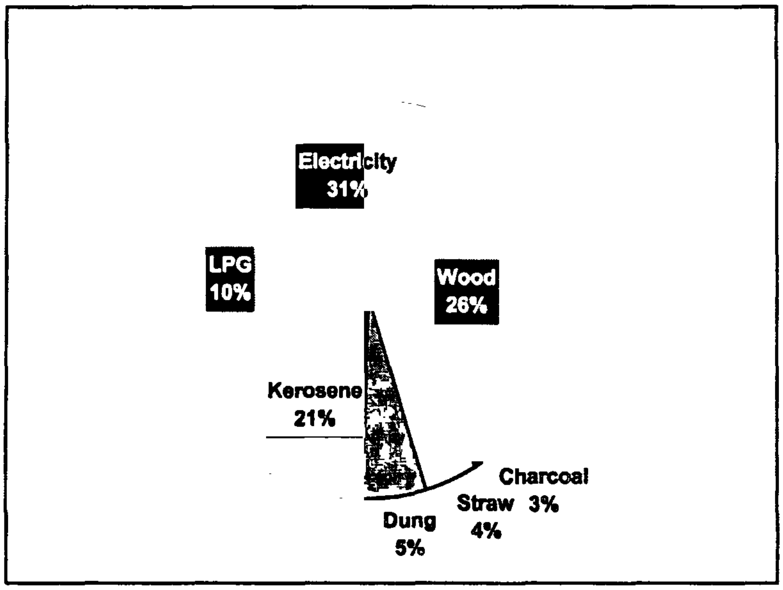
Energy Expenditures in Rural Areas

Cash Expenses for Energy

4.2 Rural people's cash incomes are still relatively low. At the time of the survey, the average monthly income for the sample was about Rs.2,300 (US$65) per family. Consequently, people do not have much cash to spend on energy, and are content to use the fuels they collect, such as fuelwood, straw, and dung, to meet their cooking needs. However, for such uses as lighting and appliances, people must purchase some form of commercial energy, usually kerosene or electricity (Figure 4.1).

4.3 As incomes rise, rural people even begin to purchase cooking energy, which can take the form of fuelwood, kerosene, and, to a limited extent, LPG. Use of electricity and kerosene for non-cooking purposes comprises about 50% of all energy expenditures. The remaining 50% is spent mainly on cooking fuels, such as wood, kerosene, and LPG.

Figure 4.1 Residential Energy Expenditures in Rural India, 1996



Source: ORG Household Survey, 1996.

4.4 Surprisingly, after kerosene, the most significant expense for the poorest households is electricity. Close to 40% of even the poorest rural households surveyed had an electricity connection. Therefore, for electrified households, expenditures on electricity are even higher than for kerosene. Although poor rural households have few appliances compared to wealthier households, they highly value electricity and are willing to spend a significant proportion of their limited incomes on it. Expenditures on energy also increase as incomes rise (Table 4.1). The poorest households surveyed purchased mainly kerosene for household lighting, while most of their cooking fuel was collected from farmlands and scrublands. They took advantage of the monthly 4-l subsidy they are permitted to purchase from ration shops.

Table 4.1 Household Expenditures on Energy in India, 1996
(Rs. per family per month)

Income decile (Rs.)	*Wood*	*Charcoal*	*Straw*	*Dung*	*Coal*	*Kerosene ration*	*Kerosenem arket*	*LPG*	*Electri-city*	*Total*
Less than 575	4.1	0.3	0.9	2.5	0.0	11.3	3.2	0.4	8.5	31.6
575-791	7.0	0.7	2.6	6.0	0.1	14.9	3.4	1.1	9.5	44.1
792-957	14.0	2.2	3.0	4.7	0.1	17.6	4.1	1.6	12.6	59.9
958-1,165	12.2	2.8	3.6	4.8	0.0	15.8	3.5	2.8	14.6	61.2
1,166-1,415	22.3	2.8	4.3	6.8	0.1	16.9	3.7	3.8	16.8	77.1
1,416-1,740	19.9	2.0	6.1	7.7	0.1	16.9	5.0	5.4	26.6	90.0
1,741-2,349	32.3	4.3	5.4	6.4	0.1	14.8	4.2	8.8	32.9	108.6
2,350-3,249	36.0	3.4	6.6	2.7	0.1	14.0	4.5	12.1	39.6	118.4
3,250-4,999	36.3	4.0	6.0	1.4	0.0	13.0	5.0	20.1	44.3	129.7
5,000 and over	31.8	4.7	0.9	2.4	0.0	12.0	3.6	29.9	57.7	143.1
State										
Maharashtra	33.7	0.6	0.2	0.9	0.0	8.3	2.5	2.3	18.8	67.9
Andhra Pradesh	18.2	0.1	7.2	6.7	0.0	16.4	4.1	4.2	14.9	72.5
West Bengal	26.9	13.3	6.7	11.3	0.3	29.3	7.9	1.7	6.8	106.5
Punjab	40.2	0.4	9.6	7.3	0.0	11.9	5.7	12.3	93.1	184.3
Himachal Pradesh	3.9	0.1	0.0	0.0	0.0	7.3	2.1	40.6	32.5	86.9
Rajasthan	5.7	0.0	0.0	0.0	0.0	11.8	1.1	1.1	16.9	36.7
Mean for sample	22.1	2.7	3.9	4.6	0.1	14.7	4.0	8.8	26.6	89.0

Source: ORG Household Survey, 1996.

4.5 The importance of lighting for poor rural households is even further underscored by the percentage of income they spend on kerosene and electricity. Because their incomes are so low, the Rs.30-60 that the lowest one-third of rural households spends each month on electricity, kerosene, and other types of energy represent 6-8% of their income (Table 4.2). Although less than half of the poor have electricity in their houses, they spend about 2% of their income on it, mainly for lighting. With increased income, the percentage of income spent on electricity falls to less than 1% of income in wealthier rural households. Likewise, because most households—rich and poor alike—take advantage of the kerosene subsidy for lighting, the percentage of income spent by poor households on lighting is about 4%, while wealthier households spend less than .5%.

Table 4.2 Percent of Income Spent on Energy in Rural India, 1996

Income decile (Rs.)	*Wood*	*Charcoal*	*Straw*	*Dung*	*Coal*	*Kerosene ration*	*Kerosene market*	*LPG*	*Electricity*	*Total*
Less than 575	0.9	0.1	0.2	0.5	0.0	3.0	1.0	0.1	2.1	8.1
575-791	1.0	0.1	0.4	0.9	0.0	2.2	0.5	0.2	1.4	6.5
792-957	1.6	0.3	0.3	0.5	0.0	2.0	0.5	0.2	1.5	7.0
958-1,165	1.2	0.3	0.4	0.5	0.0	1.5	0.3	0.3	1.4	6.0
1,166-1,415	1.8	0.2	0.3	0.5	0.0	1.4	0.3	0.3	1.3	6.2
1,416-1,740	1.3	0.1	0.4	0.5	0.0	1.1	0.3	0.3	1.7	5.8
1,741-2,349	1.6	0.2	0.3	0.3	0.0	0.7	0.2	0.4	1.6	5.4
2,350-3,249	1.3	0.1	0.2	0.1	0.0	0.5	0.2	0.4	1.4	4.3
3,250-4,999	0.9	0.1	0.2	0.0	0.0	0.3	0.1	0.5	1.1	3.3
5,000 and over	0.5	0.1	0.0	0.0	0.0	0.2	0.0	0.4	0.8	2.0
State										
Maharashtra	2.1	0.0	0.0	0.1	0.0	0.9	0.2	0.1	1.3	4.6
Andhra Pradesh	1.4	0.0	0.7	0.8	0.0	1.9	0.5	0.2	1.3	6.7
West Bengal	1.3	0.8	0.4	0.9	0.0	2.4	0.6	0.1	0.3	6.6
Punjab	1.5	0.0	0.5	0.5	0.0	0.7	0.4	0.4	4.0	7.8
Himachal Pradesh	0.1	0.0	0.0	0.0	0.0	0.5	0.1	1.5	1.6	3.8
Rajasthan	0.3	0.0	0.0	0.0	0.0	0.9	0.1	0.0	0.8	2.1
Mean for sample	1.2	0.2	0.3	0.4	0.0	1.3	0.3	0.3	1.4	5.3

Source: ORG Household Survey, 1996.

Time Spent Collecting Energy for Cooking

4.6 Increasing fuelwood shortages in rural areas have led to the development of local fuelwood markets. As a consequence, wealthier households are paying almost as much for cooking with purchased wood as they are spending on electricity for household energy. Although the most frequently used fuel for cooking in rural areas is fuelwood, its increasing scarcity is measured not only by the increasing share of wood being purchased locally, but also by the amount of time spent collecting it. For about 75% of the households surveyed, fuelwood was collected by the head or shoulder load (Table 4.3). The wood is found within a three-mile radius of the home, and collection time is, on average, about 37 hours per month. By contrast, villagers using bullock carts typically travel farther to obtain wood, make fewer trips, and spend less time per month collecting wood.

4.7 As expected, lower-income groups spend more time collecting fuelwood, mainly because higher-income households use purchased wood and commercial fuels in far greater quantity. The study found that fuelwood collection by men is significantly higher than collection by women (Table 4.3). (Similar studies in other countries also found this to be the case.) The typical pattern is that, if fuelwood supplies can be gathered easily from the local environment, then women generally collect it. However, in regions with scarce fuelwood supplies requiring travel of longer distances to collection sites, men become more involved, especially if bullock carts are used for collection. Children may collect twigs and branches from around their homes, but the task of collecting wood from more remote locations is the adults' responsibility. Finally, as might be expected, the task of collecting fuelwood weighs more heavily on lower-income groups, who collect virtually all of their cooking fuel.

Table 4.3 Family Time Spent Collecting Fuelwood in India, 1996

	Wood collection activities			*Participation in wood collection (%)*		
Income decile	*No. trips/ mo.*	*Avg. trip distance*	*Time/ mo.*	*Men*	*Women*	*Children*
Less than 575	9.9	3.7	33.9	73	66	8
575-791	12.0	3.2	35.0	74	66	9
792-957	11.3	3.2	33.4	79	64	11
958-1,165	11.0	3.2	30.9	77	60	13
1,166-1,415	10.6	2.9	30.3	81	55	17
1,416-1,740	11.5	3.4	32.9	76	59	19
1,741-2,349	9.5	3.2	30.7	80	59	17
2,350-3,249	8.6	3.5	27.5	81	53	11
3,250-4,999	7.7	3.5	26.0	90	50	15
5,000 and over	6.8	3.0	21.0	88	49	16
Collection mode						
Head/shoulder (73% of sample)	12.2	3.0	37	74	72	16
Bullock cart (21% of sample)	2.5	4.5	9.7	98	20	7
Mean for sample	9.8	3.3	30.1	80	58	14

Source: ORG Household Survey, 1996.

Access to Rural Electrification

4.8 India's rural electrification program has been characterized as "troubled." The commonly acknowledged problems of subsidies to rural consumers, especially those involved in agricultural pumping, are well documented. In this study, poor-quality service is also documented. Notwithstanding these problems, the tremendous investments in extending rural electricity service to rural areas are now in place. Most villages have electricity lines, but, because of poor-quality service and lack of incentives to expand service, the program is in a state of disarray. Although electricity lines run in all directions, for much of each day, electricity is not conveyed through them.

4.9 Despite these shortcomings, the program is reaching a surprising number of poor people (Table 4.4). It should be cautioned that the districts, selected to represent a wide range of development levels, therefore over-represent both poorer and wealthier districts. However, the figures for the percentage of households with electricity in the survey are not that much higher than those reported in the 1991 Census of India. In addition, the figures are even closer when one considers that mainly poor households have illegal electricity connections, which typically are not measured by most traditional surveys.

Table 4.4 Percentage of Households with Electricity in India, 1996
(% of households with residential connection)

Monthly household income (Rs.)	*Maharashtra*	*Andhra Pradesh*	*West Bengal*	*Punjab*	*Himachal Pradesh*	*Rajasthan*	*Total*
Less than 575	36	54	10	90	78	10	42
575-791	50	55	4	71	83	16	40
792-957	63	61	11	90	94	14	46
958-1,165	61	52	11	88	91	20	47
1,166-1,415	68	59	19	97	88	23	51
1,416-1,740	74	70	23	91	93	27	61
1,741-2,349	72	82	35	97	99	47	70
2,350-3,249	86	86	56	97	100	43	79
3,250-4,999	89	89	51	99	98	42	81
5,000 and over	94	94	53	98	98	48	83
Survey (all)*	65	64	23	94	95	34	60
Survey (illegal only)	15	12	5	6	neg	2	7
1991 census	58	36	18	77	86	22	na

* The category "all" includes both legal and illegal connections, as of 1996. Illegal connections refer to those households observed during the survey to have had an illegal line entering their houses.
Source: ORG Household Survey, 1996; Government of India, 1993.

4.10 Poor households that adopt electricity can benefit substantially. Those with electricity typically use it for lighting. The switch from kerosene lamps to electric lighting usually means a higher quantity of light at less cost, even taking into account the generous subsidies for kerosene. Rural people pay about Rs.3.2 for each liter of kerosene (about US¢10-15 per l). Interestingly, in many rural areas, the market price for kerosene is just slightly higher than the price of rationed kerosene. In many areas, the price for market kerosene is Rs.4-5 per l, which involves reselling rationed kerosene; in others, it is Rs.8-9 per l, which is closer to the world market price.

4.11 The efficiency of kerosene lamps is low, making the light they provide more expensive than electric lighting. For every equivalent kilowatt hour of energy in kerosene, the light produced is about 0.13 klm hours. By contrast, 1 kWh of electricity running through a 60-watt incandescent light bulb produces about 12 klm hours of light. Florescent lights are even more efficient, producing about 40 klm hours of light for each kilowatt hour of electricity. The analysis presented in Table 4.5 assumes that most households use incandescent lamps, so the assumptions are conservative. The results, however, are dramatic in that the subsidized or rationed kerosene costs more than Rs.2.5 per klm hour, the market kerosene costs more than Rs.5

per klm hour, and electric lighting less than Rs.0.10 per klm hour. Even if the electricity price is doubled or tripled to reach more reasonable levels, electric lighting is still far cheaper than kerosene lamps.

4.12 The price of both kerosene and electricity for lighting are the same across all income groups. This means that the subsidy policies for both kerosene and electricity are not well targeted. It is somewhat surprising that the electricity rates do not show much variation because India follows a policy of increasing block rates for electricity. However, it is apparent that, for rural areas, the blocks are too high to provide a targeted benefit to poor households.

Table 4.5 Price of Lighting in India, 1996

	Price of energy per unit			*Price of light (per klm hr.)*		
	Ration kerosene	*Market kerosene*	*Market electric*	*Ration kerosene*	*Market kerosene*	*Market electric*
Income decile (Rs.)	*Rs./l*	*Rs./l*	*Rs./kWh*	*Rs./klmn hr.*	*Rs./klm hr.*	*Rs./klm hr.*
Less than 575	3.35	6.32	1.11	2.66	5.01	0.09
575-791	3.29	6.82	1.09	2.61	5.42	0.09
792-957	3.24	6.88	1.11	2.57	5.46	0.09
958-1,165	3.28	6.93	1.11	2.61	5.50	0.09
1,166-1,415	3.26	6.77	1.08	2.59	5.37	0.09
1,416-1,740	3.22	6.83	1.17	2.56	5.42	0.10
1,741-2,349	3.24	6.69	1.14	2.57	5.31	0.09
2,350-3,249	3.23	6.67	1.13	2.56	5.29	0.09
3,250-4,999	3.23	6.42	1.11	2.56	5.09	0.09
5,000 and over	3.27	6.26	1.13	2.59	4.97	0.09
Mean for sample	3.26	6.69	1.12	2.59	5.31	0.09

Source: ORG Household Survey, 1996.

4.13 The criticism that rural electrification reaches only wealthy households is exaggerated. For the sample households surveyed in this study, the program was found to reach more than 40% of the poorest rural households (Table 4.6). Poor households seem willing to adopt electricity in far higher numbers than has been recognized previously. Besides income, another factor preventing even greater participation by the poor in rural electrification programs is the quality of their dwellings, which may not meet the standards set by the electricity distribution companies. Also, poor people frequently live away from their villages for months at a time to take advantage of seasonal wage-earning opportunities; thus, they are unwilling to pay monthly charges for a service they do not use.

Appliance Use and Energy Efficiency in Rural Areas

4.14 Virtually all households with electricity use it for lighting. As stated earlier, electricity is nearly 20 times less expensive than kerosene for producing light. In addition, florescent tubelights are four times more efficient that incandescent bulbs, so they produce even more light at lower cost. Thus, the value of electric lights for rural households is quite significant. However, use of lights varies significantly by income group. As indicated in Table 4.6, the poorest households in the sample used only one or two incandescent light bulbs, and few used florescent tubes because voltage fluctuations prevented the tubes from starting or caused them to flicker on and off. Therefore, a household that can afford one or two lamps prefers an incandescent bulb that dims only when the voltage drops.

Table 4.6 Extent of Household Lighting across All Households in Rural India, 1996

	Total households		*Incandescent bulbs (Avg. of all HH in survey)*			*Florescent tubes (Avg. of all HH in survey)*		
Income decile (Rs.)	*% HH with electric lighting*	*Total watts for lighting*	*% using bulbs*	*No. of bulbs*	*Bulb watts*	*% using tubes*	*No. of tubes*	*Tube watts*
Less than 575	42	72	41	1.25	67	9	.13	5
575-791	40	83	49	1.44	78	9	.12	5
792-957	46	79	44	1.35	75	7	.10	4
958-1,165	47	99	50	1.72	93	12	.17	6
1,166-1,415	51	108	53	1.84	102	12	.16	6
1,416-1,740	61	128	59	2.13	119	14	.22	9
1,741-2,349	70	150	63	2.45	140	16	.23	9
2,350-3,249	79	206	75	3.31	193	19	.34	13
3,250-4,999	81	251	78	3.77	229	30	.57	22
5,000 and over	83	307	82	4.57	277	36	.75	29
Average	60	148	59	2.38	137	16	.28	11

HH = households
Source: ORG Household Survey, 1996.

4.15 Use of lights, especially tubelights, increases significantly with income. The total installed wattage from incandescent bulbs available to poor households is slightly less than 70 watts, compared to 277 watts for the wealthiest households. Nearly one-third of wealthier households takes advantage of the energy efficiency of tubelights because these households already have incandescent bulbs that function during times of low voltage. Because of this greater efficiency, the price of lighting for wealthier households is likely lower than it is for poorer ones.

4.16 Use of electricity for space conditioning has been increasing steadily in rural India, mainly in the form of fans, which have several uses. In India's hot climate, a fan's most obvious use is cooling. In addition, fans circulate the air, keeping bugs from flying, thereby reducing the number of insect bites. About one-third of poor households with electricity have fans. This number would be even higher without the inclusion of Himachal Pradesh in the survey, where cooler climates dictate that only 20% of all households have fans. The percentage of households using fans rises fairly steadily with increases in income to about 70% in the wealthiest households (Table 4.7). Poor households cannot afford the expense of more sophisticated space conditioning; results of the survey confirm that virtually none has an air cooler or air conditioner. Air coolers are mainly found in Punjab, where 16% of all households own them.

Table 4.7 Extent of Space Conditioning for Rural Electrified Households, 1996

		Space conditioning appliances (Electrified households only)			
Income decile (Rs.)	*% with electricity*	*% with fans*	*Fans per household*	*% with air coolers*	*% with air conditioners*
Less than 575	42	32	0.4	0	0
575-791	40	47	0.5	0	0
792-957	46	41	0.6	0	0
958-1,165	47	47	0.7	3	0
1,166-1,415	51	51	0.7	1	0
1,416-1,740	61	57	1.0	3	0
1,741-2,349	70	62	1.2	4	0
2,350-3,249	79	66	1.4	5	0
3,250-4,999	81	68	1.5	7	0
5,000 and over	83	69	2.0	12	1
Average	60	57	1.1	4	0

Source: ORG Household Survey, 1996.

4.17 Twenty years ago, few rural households in India had a television set or access to a television signal. Today's situation differs dramatically—about 40% of the rural households surveyed have a television set (Table 4.8). As might be expected, most poor people do not own televisions. However, 10% do, and about 25% have a radio. Consequently, televisions and radios are important sources of news, information, and entertainment in rural India today.

4.18 The availability of electricity in rural areas makes possible the use of various other appliances, such as irons, mixers, grinders, and refrigerators (Table 4.8). With the exception of irons, these appliances are less prevalent than others. However, it is interesting that refrigerators are starting to appear in rural areas, with about 20% of the highest income group owning them. Most of these refrigerators are located in Punjab, where nearly 25% of all households have one. Irons, popular in all of the six states surveyed, are owned by about 40% of households.

Table 4.8 Extent of Communication and Household Devices across Rural Electrified Households, 1996

		% HH with communication devices			*% HH with household devices*		
Income decile (Rs.)	*% HH with electricity*	*Radio*	*Television*	*Tape recorder*	*Refri-gerator*	*Iron*	*Mixer/ grinder*
Less than 575	42	23	12	9	1	11	1
575-791	40	26	16	10	0	15	2
792-957	46	26	20	13	1	18	2
958-1,165	47	33	24	15	2	24	3
1,166-1,415	51	33	25	17	2	17	3
1,416-1,740	61	30	37	28	5	29	4
1,741-2,349	70	36	44	26	4	36	7
2,350-3,249	79	36	53	35	7	48	5
3,250-4,999	81	46	61	38	13	60	12
5,000 and over	83	51	68	49	22	66	20
Average	60	36	41	27	7	37	7

HH = households
Source: ORG Household Survey, 1996.

4.19 Results of the survey underscore that rising incomes in rural areas, especially those with high agricultural productivity, are leading to greater use of many forms of electrical appliances—a trend likely to grow as television introduces more rural people to them. Twenty years ago, use of electricity in rural areas was limited to better lighting; today, however, rural people are taking advantage of such appliances as fans, televisions, and other useful appliances. Moreover, rural electrification is now reaching a significant number of low-income households, who are taking advantage of electricity for lighting, fans, and other appliances.

Residential Electricity and Gender in Rural India

4.20 Theoretically, women should benefit greatly from rural electrification programs because most of the advantages occur within the household, where women spend much time preparing food, caring for children, and maintaining a proper living environment.

4.21 The evidence is compelling that women benefit from having access to electricity. Compared to unelectrified households, women living in electrified households have more leisure time; food-preparation activities are affected, as well. In rural areas, women bear most of the responsibility for food preparation; this involves not only cooking, but fuel and water collection as well. To varying degrees, rural women with access to electricity spend less time preparing food. Perhaps because they have better lighting or time-saving devices, the time required for cooking decreases from about 3 hours per day to 2.5 hours per day (see Table 4.9). Likewise, electrified households spend less time collecting fuel and water. The total time saved in food preparation is about 1 hour per day, with most of the savings attributed to fuel collection and cooking.

Tables 4.9 Time Women Spend Preparing Food in India, 1996

		Food preparation activity (with or without electricity)[1]							
	HH with electricity[2]	*Cooking*		*Food processing*		*Fuel collection*		*Water fetching*	
Income decile (Rs.)	*(%)*	*No*	*Yes*	*No*	*Yes*	*No*	*Yes*	*No*	*Yes*
Less than 600	43	2.54	2.46	1.66	1.52	1.21	0.69	1.06	1.04
600-799	39	3.10	2.75	1.80	1.58	0.97	0.65	1.03	1.01
800-949	47	3.13	2.56	1.77	1.60	0.78	0.63	1.01	0.96
950-1,159	47	3.10	2.50	1.86	1.70	0.93	0.62	0.99	0.93
1,160-1,409	52	3.08	2.74	1.87	1.48	0.86	0.64	0.92	0.92
1,410-1,749	61	3.07	2.71	1.89	1.84	0.76	0.60	0.98	0.87
1,750-2,349	70	3.14	2.56	1.82	1.84	0.94	0.54	1.03	0.92
2,350-3,249	79	3.12	2.66	2.04	1.91	0.78	0.46	1.00	0.80
3,250-4,999	82	2.88	2.50	2.08	1.97	0.73	0.38	1.14	0.78
5,000 and over	83	2.70	2.54	2.38	1.99	0.90	0.36	1.18	0.81
State									
Maharashtra	65	2.54	2.75	1.19	0.97	1.64	0.62	1.11	1.15
Andhra Pradesh	64	2.68	2.73	1.44	1.42	0.51	0.23	1.05	0.99
West Bengal	23	3.82	3.63	2.14	2.16	0.50	0.09	0.75	0.65
Punjab	94	2.28	2.47	2.52	2.59	0.65	0.32	0.71	0.56
Himachal Pradesh	96	2.42	2.18	1.99	2.07	1.30	0.90	0.73	0.63
Rajasthan	35	2.29	2.27	2.18	2.01	1.35	0.97	1.42	1.50
Average	61	2.99	2.59	1.85	1.79	0.92	0.53	1.02	0.88

[1] No = no electricity used; Yes = electricity used
[2] HH = households
Source: ORG Household Survey, 1996.

4.22 The time electrified households save in cooking activities appears to be used to increase leisure time and social activities. Ownership of television sets is having a significant effect on how women spend their evenings (Table 4.10). Clearly, those who own televisions use them. Likewise, women in households with electricity tend to read more. Of the 60% of households with electricity, 10% reported that they typically read during the course of their day. Of the remaining 40% of households without electricity, only 1% of the women reported that they read. Although the figures for reading appear low, literacy rates are also low for women in India, especially older women. Though the authors lack data on the educational level of women from the sample, those who reported that they read typically spend about 1.25 hours per day doing so.

Table 4.10 Women's Time Used for Leisure Activities in India, 1996

		Leisure activity (with and without electricity)[1]					
	HH with electricity[2]	*Listening to radio & social activities*		*Reading (studying & homework)*		*Watching television*	
Income decile (Rs.)	*(%)*	*No*	*Yes*	*No*	*Yes*	*No*	*Yes*
Less than 600	43	0.69	0.96	0.06	0.10	0.06	0.23
600-799	39	0.87	1.11	0.03	0.09	0.05	0.44
800-949	47	0.83	0.82	0.04	0.17	0.05	0.41
950-1,159	47	0.87	0.85	0.01	0.14	0.05	0.45
1,160-1,409	52	0.78	1.01	0.03	0.13	0.05	0.47
1,410-1,749	61	0.98	0.77	0.04	0.18	0.06	0.64
1,750-2,349	70	0.94	0.95	0.05	0.21	0.01	0.79
2,350-3,249	79	0.74	0.89	0.04	0.22	0.07	0.96
3,250-4,999	82	0.79	0.99	0.02	0.28	0.13	1.18
5,000 and over	83	0.63	0.87	0.01	0.32	0.14	1.17
State							
Maharashtra	65	0.21	0.43	0.06	0.17	0.04	0.52
Andhra Pradesh	64	1.37	1.41	0.03	0.10	0.07	0.40
West Bengal	23	1.04	1.25	0.03	0.18	0.10	1.28
Punjab	94	1.12	0.88	0.28	0.29	0.05	1.20
Himachal Pradesh	96	1.10	1.05	0.05	0.33	0.00	0.99
Rajasthan	35	0.49	0.47	0.01	0.03	0.01	0.18
Average	61	0.82	0.91	0.03	0.21	0.06	0.76

[1] No = without electricity; Yes = with electricity
[2] HH = households
Source: ORG Household Survey, 1996.

4.23 Rural electrification programs significantly affect women in rural India. Although the proportion of their time spent on productive activities does not increase, the time women with access to electricity spend on family and leisure activities does. The fact that women spend most of their daylight hours cooking, collecting fuelwood, preparing meals, performing productive farmwork, and caring for children means that, during the evening hours, they are better able to take advantage of electricity for reading, watching television, and socializing with their families.

Equity in Agriculture: Farmers' Use of Diesel and Electric Pumpsets

4.24 Agricultural subsidies in India are well known. However, the ways that these subsidies are divided among farmer income classes is not so well understood (see World Bank, 2001a for a recent review). The number of farmers taking advantage of the electricity subsidies varies significantly among farmer classes and states. Because of greater access to agricultural pumps, Punjab, the wealthiest state in this study, and the large-farmer class are taking greater advantage of the agricultural pumping subsidies. Although marginal farmers comprise about 43% of the farm population in the six states studied, they have only 5% of the electricity pumpsets (Table 4.11). Likewise, adoption of electricity for agricultural pumping is highest in Punjab. In most of the other five states surveyed, farmers are not using diesel pumps to any great extent. While subsidies for agricultural pumping appear to be drawing farmers away from using diesel pumps, other reasons may also account for this shift, such as greater convenience and avoidance of problems associated with diesel engines using submersible pumps.

Table 4.11 Extent of Electric and Diesel Pumping, by Farmer Class, 1996

Farmer category	*Total farmers in category (%)*	*Farmers with pumps (%)*	*Farmers with electric pumps (%)*	*Farmers with diesel pumps (%)*
Class				
Large (> 3 ha)	23	34	27	13
Medium (2-3 ha)	9	27	21	8
Small (1-2 ha)	25	21	16	9
Marginal (< 1 ha)	43	8	5	4
State				
Maharashtra	Na	23	22	1
Andhra Pradesh	Na	13	10	2
West Bengal	Na	6	1	6
Punjab	Na	83	60	52
Himachal Pradesh	Na	1	0	1
Rajasthan	Na	13	6	7
Total/average	100	14	14	8

na = not applicable
Source: ORG Household Survey, 1996.

4.25 Large farmers, presumably in a position to pay more for electricity, are obtaining the largest share of the subsidies directed toward agricultural pumping. In addition to owning more pumps, large farmers use more electricity. One reason for this is that a larger farm tends to run its pumps for longer periods of time; it also tends to purchase larger pumps. The pricing of electricity in most areas is based on pump size, not electricity use. As a result, large farmers pay less per kilowatt hour for electricity than do smaller farmers. Large farmers, who represent 23% of the farmer population in the survey, consume about 50% of the electricity and pay about 50% of the agricultural electricity revenues collected by the state electricity companies (Table 4.12).

Table 4.12 Extent of Electricity Use for Pumping, by Farmer Class, 1996

	Total farmers in category	*Farmers with pumps*	*Average pump capacity*	*Electricity consumption*		*Electricity expenditures*		*Electricity price*
Farmer class	*%*	*%*	*Horse-power*	*kWh/ year*	*% share*	*Rs./ year*	*% share*	*Rs./ kWh*
Large (> 3 ha)	23	34	5.8	5,735	54	2,824	49	0.76
Medium (2-3 ha)	9	27	5.2	4,498	13	2,347	13	0.78
Small (1-2 ha)	25	21	4.5	3,635	23	2,295	26	0.93
Marginal (<1 ha)	43	8	4.0	3,214	10	2,012	12	0.92
Total/average	100	14	5.1	4,606	100	2,492	100	0.84

Source: ORG Household Survey, 1996.

4.26 Large farmers, who generally can afford the pumping services used in a profitable agricultural business, make use of both diesel fuel and electricity. Use of diesel for agricultural pumping follows patterns similar to those for electricity. Regardless of the energy source, larger farmers are better able to take advantage of pumping because they own enough land to make use of water from large pumps. Diesel is subsidized, but to a lesser degree than electric pumping. Consequently, the diesel price per delivered kilowatt hour of electricity is twice as high as electricity (Table 4.13), not taking into account operating and maintenance costs. This indicates that the willingness of farmers with diesel pumpsets to pay for electricity is at least twice the value of the agricultural tariff.

Table 4.13 Extent of Diesel Use for Pumping by Farmer Class, 1996

	Total farmers in category	*Farmers with diesel pumps*	*Average pump capacity*	*Average diesel consumption (users only)*		*Average diesel expenditures (users only)*		*Diesel price in kWh**
Farmer class	*%*	*%*	*Horese-power*	*kWh / year*	*% share*	*Rs./ year*	*% share*	*Rs./ kWh*
Large (> 3 ha)	23	13	7.4	11,152	39	8,719	41	2.03
Medium (2-3 ha)	9	8	6.9	17,996	12	13,346	12	1.87
Small (1-2 ha)	25	9	6.4	12,755	33	9,382	31	1.92
Marginal (< 1 ha)	43	4	5.4	8,175	16	6,111	16	1.92
Total/average	100	8	6.6	11,475	100	8,696	100	1.96

*The diesel price in kWh is the energy content equivalent adjusted for energy efficiency.
Source: ORG Household Survey, 1996.

Conclusion

4.27 As expected, income differences play an important role in the energy and appliances mix in rural households. Wealthier households spend a larger cash amount but a smaller percentage of their income on energy, compared to poorer households. Government programs having the greatest effect on energy expenditures are the public distribution program for kerosene and the rural electrification program. Ironically, the other main expenditure is for purchased fuelwood, which is priced according to market conditions.

4.28 The kerosene distribution program is effectively reaching nearly all households in rural areas. Well-off and poor households alike purchase and consume similar amounts of kerosene. Recently, private markets for kerosene opened up for rural areas, but the little kerosene that was purchased through the market appears to be rationed kerosene sold to neighbors and friends. The ration program also appears to limit kerosene use in rural areas to lighting because not enough kerosene is purchased to justify cooking with it. Significant subsidies go to those who can afford to pay for kerosene at market prices.

4.29 The kerosene subsidy scheme for rural household lighting was established during a period when few rural residents had access to electricity for lighting. Currently, more than 40% of the poorest households use electricity in the six states surveyed, although the supply is unreliable. For wealthier rural households that now use electricity, the kerosene subsidy no longer provides the essential service for which it was originally intended. Implications of the study's findings are that the subsidy for lighting in rural areas should be targeted more toward poor households. Moreover, rural households are allowed to purchase only 4 l of subsidized kerosene per month, compared to the 15 l that urban households are allowed, clearly reflecting a policy bias toward urban markets.

4.30 Despite its problems, the rural electrification program is beginning to reach a significant number of poor households. Electric lighting significantly benefits rural households, especially women, who are 10 times more likely to read in households that are electrified. The effect of rural electrification on agricultural productivity has been a significant feature of India's development program (Barnes 1988). However, the problems associated with the subsidies extended to farmers using electric pumps are well documented. Given the weakness that subsidies are causing the financial health of state electricity companies, an important question is whether these subsidies are being distributed equitably in rural India.

4.31 Given the significant investments that have already been made in lines and equipment to reach over 90% of India's rural villages, it is now time to consider ways to encourage the remaining poor to adopt electricity as perhaps a replacement for the kerosene subsidy. Some possible ways to accomplish this include setting tariffs with low lifeline rates to reach the poorest households, along with re-evaluating connection policies. Techniques might be developed to have inexpensive line extensions for substandard housing. The study survey indicates that many poor households are already doing this through illegal tapping of electricity using substandard techniques. Another way to encourage the poor to adopt electricity is to find ways to service migrant agricultural workers when they return to their villages. Once such issues are addressed, the kerosene subsidy for lighting might possibly be eliminated.

5

Major Energy Markets and Their Policy Framework

5.1 In rural India today, biomass persists as the predominant fuel. The rural people surveyed in this study expressed concern over increasing fuelwood shortages, which are forcing poorer households to switch to dung and crop wastes and the purchasing of commercial fuelwood supplies.

5.2 Apart from the public distribution program, petroleum fuels are not extensively used in India's rural areas. Rural petroleum markets are not well developed because of past polices that favored urban areas. Although LPG use is starting to occur in some states, there is no significant access at present.

5.3 More than any other rural energy program in India, the country's rural electrification program has probably had the greatest effect. Introduction of electricity has vastly improved the quality of lighting in rural households, allowing increased use of fans, television sets, irons, and other appliances. Electrification of pumpsets has promoted major increases in agricultural productivity and rural incomes. But widespread subsidization has weakened the financial standing of the SEBs, leading to deterioration in electricity service.

5.4 Despite allocation of substantial resources to the country's renewable energy program, penetration of renewable energy devices in rural areas remains low. This fact demonstrates that target-driven approaches have not succeeded and should be replaced by others based on market principles.

5.5 This chapter examines ways in which energy services are provided to rural areas in India. For each of the sectors mentioned above, the major problems are identified, along with past and current policy regimes; in addition, areas are highlighted in which change is required if access to modern, efficient energy is to improve.

Biomass Fuels

5.6 Fuelwood, crop residues, and dung are, by far, the major sources of energy in rural communities because of their local availability, renewability, and low collection cost. Access to adequate supplies of biomass fuels, consistent with long-term sustainability, is therefore of primary importance to rural populations, both now and in the foreseeable future (Government of India, Ministry of Environment and Forests 1993; Ravindranath and Hall 1995). This study's survey of rural biomass supplies concluded that fuelwood, the preferred biomass fuel,[5] is in generally short supply on a sustainable basis (Table 5.1). On the other hand, sustainable supplies of crop residues and dung are higher than estimated demand. If all types of biomass—fuelwood, crop residues, and dung—are taken together, then sustainable supplies appear adequate to meet demand in all of the surveyed states, except West Bengal. The problem is that the composition of biomass supplies does not match consumer preferences.

Table 5.1 Estimated Demand for and Sustainable Supply of Rural Household Biomass Energy, 1996
(tonnes of oil equivalent, except where stated)

	Woodfuel			*Crop residues*			*Dung*			*Total biomass*		
State	*D*	*S*	*D/S (%)**	*D*	*S*	*D/S (%)**	*D*	*S*	*D/S (%)**	*D*	*S*	*D/S (%)**
Rajasthan	9.98	2.80	365	2.43	12.82	18	2.55	4.27	53	14.96	19.89	75
Punjab	1.78	0.61	292	1.05	5.93	18	1.89	1.52	124	4.72	8.06	59
Himachal Pradesh	1.66	5.26	32	0.01	0.73	1	0.02	0.40	5	1.69	6.39	26
Maharashtra	11.55	9.50	122	1.33	11.84	11	1.51	4.34	35	14.34	25.68	56
Andhra Pradesh	7.28	9.48	77	3.88	5.52	70	0.44	6.22	7	11.60	21.22	55
West Bengal	7.19	1.22	589	6.17	6.58	94	2.15	4.10	52	15.51	11.90	130

D = demand; S = supply
* A demand/supply ratio of more than 100 indicates that demand is higher than sustainable supplies.
Source: World Bank Draft Working Paper for this study, 1998.

Facing the Fuelwood Shortage

5.7 Shortage of fuelwood is pervasive. In four out of the six states surveyed, estimated wood demand for household energy is greater than estimated sustainable supply (i.e., the ratio of demand to supply is greater than 100) (Table 5.1). Ironically, Himachal Pradesh, the state with the greatest estimated surplus of sustainable supply over demand, has the most aggressive policies for combating deforestation. At the other end of the spectrum is West Bengal, where fuelwood demand is nearly six times sustainable supply.

5.8 Because these data exclude trees grown outside the forest, they underestimate total fuelwood supplies. This points to the compelling need for proper and timely inventories, especially of trees outside the forest, as a basis for developing effective fuelwood strategies. Even taking into account this bias toward underestimation, however, it appears that, in most states, demand for fuelwood exceeds sustainable supply, and that, consequently, the tree capital is being drawn down.

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[5] In four of the six states surveyed (Andhra Pradesh, Maharastra, Rajasthan, and Himachal Pradesh), 75% or more of all rural households use fuelwood; in the other two states (Punjab and West Bengal), about 40% use fuelwood. Fuelwood is generally preferred because it is less bulky, burns longer, and provides a more predictable, sustained heat than do dung and crop wastes.

5.9 Lack of sustainable fuelwood supplies is supported by other evidence. In a survey of attitudes toward energy supplies, 90% of householders and 85% of village leaders agreed that a fuelwood shortage exists. The majority was of the opinion that fuelwood supplies had declined in recent years. Fuelwood shortages are also evidenced by poorer households' shift from fuelwood to lower-value sources of energy, such as crop residues and dung cakes.

5.10 Another indication of fuelwood shortages may be the extent of household purchases of commercial supplies. Traditionally, fuelwood has been gathered free of charge, with the cost to the household limited to the labor expended to gather it. Indeed, free collection has been one of fuelwood's main attractions, when compared with kerosene or LPG. Even today, free collection accounts for 70% or more of total fuelwood use. In several states (Andhra Pradesh, Punjab, and West Bengal), however, 25-40% of fuelwood supplies are now purchased rather than collected. The development of fuelwood markets suggests a growing scarcity of freely available supplies. The need to buy fuelwood imposes an economic burden on rural householders, particularly as most have low incomes. Looking ahead, however, commercialization often represents the first step up the fuel substitution ladder. As householders become more aware of the true costs of fuelwood use, competing fuels will likely appear more attractive.

5.11 The imbalance between sustainable wood supply and demand points to the need to increase sustainable supplies; modify demand through improved end-use efficiency, especially in cooking; and, where possible, substitute fuelwood with other fuels.

Non-woody Biomass Challenge

5.12 After fuelwood, dung is the most commonly used biomass fuel, although crop residues are used more frequently in Andhra Pradesh and West Bengal. Generally, all states except Punjab appear to have an ample supply of dung (Table 5.1). In Punjab, higher rural incomes provide greater opportunities for substitution with superior fuels. All states, with the exception of West Bengal, appear to have ample supplies of crop residues. The least popular biomass cooking fuel, crop residues burn quickly, their fires need constant attention, and they tend to produce particulates, which affect the respiration of those confined to the kitchen for long periods of time.

5.13 As in the case of fuelwood, demand estimates for dung and crop residues must be viewed with caution. Such estimates do not include the use of biomass for animal feed and fertilizer; thus, levels of total demand, including non-household and household use, will be higher than those given here. Biomass supplies are inherently difficult to estimate, and are prone to error. For example, there must be an error in the supply/demand calculation for Punjab, as it indicates that demand is 124% of supply, which is impossible since no major stocks of dung are held. In this case, demand must have been overestimated and/or supply estimates under-recorded. This example illustrates why inventories should be conducted in the field, rather than rely on default values.

5.14 With the above reservations, supplies of non-woody biomass appear adequate. The challenge is to convert them from their present inefficient, inconvenient form into sources of cleaner, more efficient, and reliable forms of energy.

Policies and Programs

5.15 Until recently, fuelwood has been the only form of biomass fuel to attract government attention, largely as a by-product of forestry policies. The Ministry of Environment and Forests and the State Forestry Departments have traditionally focused on conservation of forest resources (both flora and fauna), and have included a policing function to ensure that supplies would not be unlawfully extracted from forest areas. In recent years, partly in response to the growing fuelwood shortage and deforestation in many areas, the focus has changed somewhat. The 1988 National Forest Policy mandated involvement of local people in forest management and added fulfillment of rural people's fuelwood requirement to the traditional mandate of forest conservation and afforestation. The role of local communities as the primary stakeholders has also become the guiding principle for all social forestry projects.

5.16 At the state level, supplies of traditional fuels are of more direct concern. Indeed, many state energy initiatives are motivated primarily by the need to alleviate traditional fuel shortages. Each state has a forestry department, whose traditional responsibility is forest conservation. In recent years, however, greater emphasis has been placed on responsiveness to rural energy needs. Many states have established special social forestry programs, whose common features include the following:

- protection of existing forests and increases in forest cover;
- planting species on community wastelands and village common lands to provide fuel, fodder, and small timber;
- community participation in forestry programs;
- seedling distribution;
- roadside plantings;
- plantations of fast-growing species;
- integration of forestry, agriculture, and animal husbandry programs; and
- soil conservation demonstrations.

5.17 These initiatives are frequently carried out with support from outside donors. In Andhra Pradesh and Himachal Pradesh, for example, the World Bank, German Agency for Technical Cooperation (GTZ), and Overseas Development Agency (ODA) support the Directorate of Social Forestry program. The World Bank, together with the United States Agency for International Development (USAID) and the World Food Program, also supports social forestry in Rajasthan.

5.18 A top-down management style of community forestry, which has been promoted in the past, has, on the whole, had disappointing results. Conversely, participatory forestry, whereby local people actively participate in decision-making, appears to be having more success. Even so, many state forest services are reluctant to hand over forest areas to villagers. Also, in all of the six states surveyed, closed forests are concentrated in specific areas to which many groups lack access. Therefore, such a policy is effective only for villagers living close to the forest or woodland resources.

5.19 Looking toward the future, meaningful policies cannot be formulated unless the resource situation is clear. Major efforts are required to increase immediately available supplies of fuelwood, the preferred form of biomass energy, which is in shortest supply.

5.20 On the demand side, several programs have been developed. These include longstanding ones to improve stove efficiencies and to convert dung into biogas (see "End-use Energy Efficiency in Rural Areas" section of this chapter). Among the states studied, Himachal Pradesh is best endowed with fuelwood resources; nevertheless, it has introduced aggressive polices to slow deforestation by subsidizing pressure cookers to improve cooking efficiencies and by subsidizing LPG to encourage households to substitute for fuelwood.

Petroleum Products

5.21 In India, as in many countries, the oil and gas sector has been comprehensively controlled and regulated until recent years. In response to the need for capital and advanced technology to increase production and develop new reserves, the Government of India has begun to open up prospecting, extraction, refining, and exportation to private capital, including foreign investors. Supply-side liberalization has been paralleled by developments in distribution and marketing. Imports of widely-used petroleum products (kerosene and LPG) have been liberalized, and private entrepreneurs are now allowed to import and sell these products on the domestic market through their own, rather than government, outlets. However, these changes have modified, not replaced, the old system, which still characterizes the distribution markets in certain respects.

Kerosene: The Rural Dilemma

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

5.23 The system of controlled supplies and subsidized prices was designed to ensure poor consumers access to at least a minimal amount of modern fuels. To some extent, this aim was fulfilled. As this study's survey shows, kerosene is widely used in rural areas in all six states, even by low-income households. But, as is widely recognized, it is difficult to target subsidies; thus, richer, as well as poorer, households benefit. In this survey, per-capita consumption of kerosene was similar across states and income groups, at a level that suggests that all households—whether rich or poor—consume their rationed allocation, but use little more.

5.24 Limited supplies have discouraged the use of kerosene as a cooking fuel. In rural areas, the monthly kerosene ration has been just 4 l per household, compared to 15 l per household in urban areas. Consequently, rural households have been unable to make the same transition to modern fuels that poorer urban households have, and an opportunity to reduce pressure on fuelwood supplies has been lost. The recent liberalization of kerosene markets appears to have improved supplies in urban areas, although it is unclear whether rural areas have also benefited. Even if supplies have improved, prices will have almost certainly increased, an important consideration for rural households, whose incomes are generally lower than those in urban areas and where (free) biomass fuels are more accessible.

Liquefied Petroleum Gas: Use Incentives and Policy Questions

5.25 LPG is a favored form of cooking energy in urban areas. Demand has risen rapidly, despite the high cost of cylinders, which has resulted in long waiting periods for obtaining connections and refills—delays that have led to the development of black markets. Recently, the government liberalized the LPG trade, providing attractive fiscal incentives to private investors to refine, bottle, and distribute LPG. Furthermore, customs duties on LPG imports were reduced from 85% to 25%. LPG prices to domestic consumers were allowed to rise, although in reaction to popular pressure, the extent of the price rise was later adjusted. To encourage LPG use, a program known as "Tatkal" was introduced, whereby cylinders are provided on demand by charging a premium in the form of a non-refundable deposit. Results of Tatkal on urban energy use have been dramatic. In Hyderabad, LPG replaced kerosene as a cooking fuel in a short period of time, even in relatively poor households.

5.26 Under the former distribution policy, LPG did not penetrate into rural areas, and even recent marketing liberalization may not have made it widely available. In any event, for most rural households, LPG is too expensive, although increasing use has been observed in such states as Punjab, which is equipped with a sound transport infrastructure and higher incomes, as well as in Himachal Pradesh, where strong financial incentives to use LPG have been provided in an effort to slow deforestation. Although LPG accounts for only a small portion of the total energy used for cooking in these states, its role is effectively larger because of its much higher end-use thermal efficiency. For example, LPG accounts for only 4% of the total input energy used in cooking in Himachal Pradesh; however, when this input energy is corrected for thermal efficiencies, LPG's share rises to about 20% of the state's use of energy for cooking.

5.27 The effectiveness of the Himachal Pradesh LPG subsidy scheme (LPG consumption in that state is more than 10 times higher than in most other states and 3 times higher than in the relatively high-income Punjab) shows that it is possible to promote new fuels, and that consumers willingly adopt them when they are provided strong incentives. The policy questions center on the effect of this program on deforestation and its cost and efficiency in relation to other options to preserve forests, such as tree planting and improved fuelwood stove efficiency.

Diesel and Gasoline: Key Uses and Subsidy Issues

5.28 In addition to household use, petroleum products play an important role in agricultural development. Diesel is a major fuel for irrigation pumping, both as a backup to electric pumps and as the only form of mechanical irrigation when electricity is unavailable. Diesel is also extensively used in other farm equipment, including tractors, thereby representing an important component of agricultural development. Diesel and gasoline are both used in essential transport services linking rural areas to urban markets.

5.29 Implications of the diesel subsidy program differ markedly from subsidy programs of other petroleum products because, in irrigation pumping, the diesel subsidy has been surpassed by an even larger electricity subsidy for agricultural use. At current prices in several states, electric pumping is far cheaper than diesel pumping; therefore, along with other advantages, it is the preferred irrigation technology. Without such generous electricity subsidies, diesel pumps might be more widely used.

5.30 While the older system of controlled pricing and supplies provided poor households access to petroleum products, these policies have had negative side effects. Chronic shortage and unreliable supplies of petroleum products in rural areas have constrained consumption, distorted consumption patterns, and imposed a heavy expense on users obligated to maintain elaborate backup systems. These problems have also hindered the transition to cleaner, more efficient fuels that place less stress on human health and the environment. The trend toward loosening these restrictive policies has resulted in improved supplies to rural areas. In most states, markets for these fuels are still limited, as liberalization is having a greater effect in urban, rather than rural, areas.

Electricity

5.31 Although village electrification has proceeded apace, households still have limited access. Some states, such as Punjab and Himachal Pradesh, have achieved remarkable coverage rates of 90% or higher, while others lag far behind. Supplies are unreliable and of poor quality, requiring major investments by households to compensate for voltage fluctuations and maintain backup systems. Subsidized prices have seriously weakened the financial viability of the SEBs, and have diminished incentives to use electricity efficiently. The rural tariff structure contains many anomalies. Although often ignored, households in rural areas pay higher prices for electricity than do agricultural customers. Virtually all households are metered, and the rates that households pay are double or triple the low agricultural rates. Many of these problems can be attributed directly to the policy environment.

Obstacles to Household Adoption

5.32 In contrast to its policy toward biomass fuels, the Government of India, since independence, has been committed to increasing the supply of electricity to rural villages. During the 1950s, however, the pace of rural electrification was slowed because of an overall focus on the industrial sector. As a result, India's 3,000 electrified villages in 1950-1951 increased to only 22,000 a decade later.

5.33 Famines of the mid-1960s prompted the government to shift its focus from rural village electrification to exploitation of ground-water pumping in order to increase agricultural yields. To accomplish this, in 1969, the Rural Electrification Corporation was made responsible for accelerating the pace of rural electrification and encouraging the use of electricity for irrigation. The Corporation provides over 90% of the funds for expansion of electricity distribution in the form of concessional loans to the SEBs. By 1995, nearly 500,000 villages (90% of the total) had electricity, and the number of electric pumpsets had reached 10 million. Although these figures appear impressive, the focus on agriculture has meant that adoption by households has not kept pace. In 1991, some two-thirds of rural households in India remained without electricity (Government of India 1993).

5.34 However, the pricing policies imposed on the SEBs have had serious effects on their financial health (Table 5.2). These policies set rural domestic prices at the same level as urban prices, implying an implicit subsidy, since distribution costs are typically much higher for rural customers. An early promotional policy of low prices to encourage farmers to switch from diesel to electric pumps has been continued for decades. Furthermore, many states now provide farmers electricity free of charge, which disproportionately benefits wealthier farmers. Subsidies to agricultural consumers in 1994-1995 were estimated at Rs.138 billion (US$4.1 billion), and those to domestic consumers at Rs.32 billion (US$1 billion).

Table 5.2 Electricity Sales and Tariff Structure, 1994-1995

Sector	*%*	*Tariff (paise/kWh)*	*Tariff (US¢/kWh)*
Domestic	15.7	92.1	2.7
Commercial	4.5	228.7	6.8
Industry	34.1	221.4	6.6
Agriculture	32.5	19.4	0.6
Transport	4.9	254.3	7.6
Outside state	8.3	109.7	3.3
Total/average	100	134.5	4.0

Note: US$1 = Rs.33.7
Source: Government of India, 1997.

5.35 As agriculture's share of electricity consumption has risen from 10% in 1970-1971 to 32% in 1994-1995, the SEBs' financial difficulties have worsened. As a group, the SEBs lost Rs.46 billion (US$1.4 billion) during 1994-1995, with only four SEBs showing a profit. As a result, the SEBs' current standards of service are poor since they lack sufficient resources to finance their own programs and are unable to mobilize enough external resources to invest in new projects. In addition, connection policies discourage widespread adoption of electricity.

The Government's Response

5.36 The financial weakness of the SEBs, combined with poor service and low household connection rates, led to key policy changes in 1995-1996, when the Government of India laid out a common minimum action plan for power, including the establishment of state and central electricity regulatory commissions (World Bank 1999). This action plan was designed to result in the rationalization of retail tariffs, private-sector participation in distribution, SEB autonomy, improved SEB management and operational practices, and the encouragement of cogeneration and captive power plants.

5.37 At the federal level, the Government of India initiated a major policy initiative to make the generation and supply of electricity commercially viable. In April 1998, it issued the Electricity Regulatory Commissions Ordinance (ERCO) for setting up the Central Electricity Regulatory Commission (CERC) and the State Electricity Regulatory Commissions (SERCs) for tariff rationalization and other activities. The CERC sets the bulk tariffs for all central generating and transmission utility companies and decides on issues concerning interstate exchange of electricity. The SERCs have the authority to set tariffs for all types of electricity customers in their respective states; however, state governments are entitled to set policies with respect to subsidies allowed for supply of electricity to any consumer class, and are authorized to cross-subsidize.

5.38 State and central regulatory commissions are now being established. Orissa was the first state to introduce major power-sector reforms through enactment of the Orissa Reforms Act of 1995, which went into effect in April 1996. The Haryana State Assembly adopted the Haryana State Restructuring Bill of 1997, and Rajasthan, Gujarat, and Andhra Pradesh are following a similar course. Other states, including Maharashtra and Punjab, have initiated actions for undertaking similar reforms.

5.39 A major objective of the new power-sector policy is to reduce the subsidy to agricultural customers, currently estimated at Rs.65 billion for the six states surveyed over a three-year time frame. At the end of this period, tariffs for any consumer class, including agricultural consumers, are to be not less than 50% of the cost of supply. If this objective is achieved, then the current level of subsidies to agricultural users could fall by nearly 50%.

5.40 ERCO is designed to allow restructuring of the electricity supply business. In the case of Orissa, electricity generation may be separated from transmission and distribution. For the transmission of electricity, the Grid Corporation of Orissa, Ltd. was created. Distribution of electricity is to be handled by private-sector licensees, who will operate under rules set by the SERCs. A gradual process of privatization, beginning with one or two geographical areas covering both urban and rural domains within a state and then spreading to other parts of the state is to be initiated. The privatization process is designed to improve the quality of electricity supply to rural customers and to provide better bill collection and metered electricity service.

5.41 As in the case of biomass fuels, there is considerable potential for improving the efficiency with which electricity is used. Rising prices will provide incentives, but reinforcing policies may also be necessary.

Renewable Energy

5.42 India's renewable energy program has been more active than those in most other developing countries. The importance of renewable energy was further enhanced in 1992, when the Department of Non-Conventional Energy Sources was upgraded to the Ministry of Non-Conventional Energy Sources. Though the Ministry's programs are evolving toward more market-oriented approaches, many of its existing programs are still largely driven by targets and extensive subsidies. Its many and varied programs include such technologies as biomass gasification, biomass combustion, domestic PV lighting systems, small hydropower, solar lanterns, and wind-battery charging, among others.

Promotion Strategies

5.43 The government's strategy for promoting renewable energy takes three approaches. The first involves government funding of selected research and development programs that often result in demonstration projects. The second approach makes government-supported financing (with external assistance) available to commercially viable projects, including those implemented by the private sector. For example, the microhydro program involves private-sector loans to develop electricity from renewable energy and sell it to the grid or wheel it to a company's customers. The third approach involves government-promoted investments through fiscal incentives, tax holidays, accelerated depreciation allowances, facilities for distributing and storing grid-quality power, and a remunerative price for power generated from renewable energy sources.

5.44 Although certain subsidies are being phased out, most programs still involve subsidies or financial incentives. For example, a 30% subsidy for the capital costs of biomass combustion is available. Solar cookers are exempt from excise taxes, and soft loans are given for manufacturing them. For large wind power that generates electricity for the grid, incentives involve a 100%-accelerated depreciation and a five-year tax exemption. Small hydroelectric projects receive a subsidy of up to 50% of the costs of the electrical, mechanical, and civil works, as well as subsidies for systems installed in hilly or high-elevation areas. One program to promote solar water pumping has involved a subsidy of about Rs.150,000 per system. Despite these generous subsidies, the target-driven approach to promoting renewable energy has resulted in a low penetration of renewable energy devices into rural areas.

Obstacles to Rural Adoption

5.45 The challenges of promoting rural adoption of renewable energy, especially PVs, are perceived as quite similar by a range of groups. The main groups consulted in this study about dissemination problems were the renewable energy industry, nongovernmental organizations (NGOs) who promote renewable energy, and rural populations that might potentially purchase such systems (Table 5.3). All three groups attributed poor adoption to lack of awareness of renewable energy products, high system costs, and lack of credit for purchasing systems.

Table 5.3 Perceived Barriers to PV Commercialization in Rural India, 1996

Group consulted	*Type of barrier*			
	Lack of credit	*Lack of awareness*	*High cost*	*Unavailability*
Renewable energy businesses industry	x	x	x	
Rural NGOs		x	X	x
Rural population	x	x	X	

Source: Biswas, 1997.

5.46 Reception to these government programs by the renewable energy industry, particularly the PV industries, has been mixed. On the one hand, industry executives (interviewed for this study by Winrock International's Renewable Energy Project Support

Offices [REDSO]) believed that policies to promote renewable energy were not being administered in a way that contributes to the industry's long-term development. In particular, the approaches followed often involve government equipment purchases for subsequent resale to rural residents at subsidized prices (i.e., government programs, not the final users, are the market for their products). A few renewable energy companies complained that the pilot promotion schemes have created a subsidy-oriented mindset among rural consumers, and several indicated that government programs have created unrealistic consumer expectations.

5.47 Both NGOs and the renewable energy industry complained that the playing field is not level for most renewable energy. Subsidies to alternative technologies, such as grid electrification and kerosene for lighting, hurt demand for some renewable energy technologies. The electricity laws also make it somewhat difficult for small, renewable-energy- based grid systems to charge prices based on their costs to rural consumers. The consequence of such pricing is that organizations cannot gear their electricity generation to renewable energy, which is generally more expensive that electricity from other sources.

5.48 Specific renewable energy devices are entering a phase in which they are competitive with alternatives, given a level playing field and appropriate government policies. A pervasive lack of awareness of renewable energy technologies in rural areas reflects the failure of traditional dissemination approaches. In concurrence with the Bank's most recent publication on rural energy and development (World Bank 1996), the government's role should not be one of buying and distributing renewable energy technologies; rather, it should support market development through promotion, demonstration, and quality control. Market development includes commercial pricing and private involvement in distribution and retailing, creating innovative and effective incentives for banking and micro-finance schemes, and assuring the quality of renewable energy technologies.

End-use Energy Efficiency in Rural Areas

5.49 Energy efficiency is especially important in rural areas of India, where supplies are limited and the need for mitigating environmental damage is urgent. Early on, the Government of India recognized the importance of energy efficiency and has sponsored several major programs. These have met with mixed success, and a great potential for improving efficiencies remains.

Improved Stoves

5.50 Fuelwood, crop residues, and dung constitute the bulk of fuels used for cooking-related activities (typically over 90%). These traditional fuels are used with various types of stoves (chulhas)—both traditional and improved (portable and fixed). Most of the households surveyed in this study owned at least one traditional chulha, and many owned more than one.

5.51 The cooking efficiency of the chulha is a function of its design, number of pots and pans placed upon it, and the type of food that is cooked. Standardized tests for estimating thermal efficiency of wood-fueled stoves indicate that traditional chulhas operate at only one-half the efficiency of standard improved stoves.[6] Dung cakes yield even lower efficiency because they have lower heat intensity, and the greater distance from the low flame to the pot or pan may increase heat loss.

5.52 India's national program to subsidize, disseminate, and promote the use of improved chulhas in villages was initiated in 1984-1985 with the purpose of saving fuelwood. By March 1996, more than 2.5 million of these stoves were installed, covering an estimated 20% of potential households. (Improved chulhas require a minimum efficiency of 20% for fixed mud stoves and 25% for portable metal stoves in order to receive approval from the Ministry of Non-Conventional Energy Sources.) This program has met with some success. Improved chulhas were present in all the villages surveyed and were generally available in village markets; about 70% were reported to be in good working order. Most villagers were aware of these devices, and those who expressed their opinions agreed that the improved chulhas not only saved fuel but were healthier to operate, substantially reducing indoor air pollution.

5.53 Despite extensive governmental promotion efforts, improved chulhas still account for less than 10% of the total stock of chulhas. Reasons for limited program successes, which vary significantly by region, are not entirely clear. One criticism of this and other similar government programs is that they are *target-driven*, rather than *need-driven*. Subsidies are used to encourage the distribution of chulhas without paying adequate attention to consumer requirements and after-sale servicing. Extensive subsidies deter the development of local markets, which might be more efficient in manufacturing and servicing improved stoves. Stove designs might also be unsuitable for some types of foods or other cultural requirements in specific areas.

5.54 In contrast to the chulhas used by households, which tend to be small in size, enterprises (e.g., small restaurants, student hostels, and schools) use chulhas that can serve 50-400 persons. Typically, these enterprises buy fuelwood from local markets, and are consequently more cost conscious than householders. Large stoves, such as the Harsha and SK Delux community stoves, have been developed to serve this market; thermal efficiencies range from 30 to 50%, at a cost of Rs.500-1,000 per chulha.

5.55 The survey revealed that, in several states, pressure cookers are used extensively. They reduce fuel use by accelerating cooking time, and are especially effective in high-altitude areas, such as Himachal Pradesh. Pressure cookers appeal to consumers as an energy-efficient device. They can be used on existing chulhas, without any modification, are well suited to the cooking typical of the area, are widely available in local markets, and meet with a high level of user enthusiasm. Pressure cookers can improve the efficiency of fuel use by as much as 25%. In some states, notably Himachal Pradesh, they are subsidized as part of a broader effort to check deforestation. The survey showed great variation in ownership between states. Further examination of these differences could help identify factors that encourage rapid adoption.

5.56 Opportunities also exist for improving the efficiency and convenience of using dung. Generally burned directly, dung can be passed through a digester, enabling the methane

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[6] PHU, a measure of the ratio of useful heat to total heat content of a fuel, is defined as the heat gained by water in the pans, divided by the heat supplied by the combustion of the fuel multiplied by 100. The traditional fuelwood stove, as it turns out, has a PHU of 15%, compared with 34% for the improved ASTRA stove.

(biogas) to be extracted and used for energy, while the residual slurry can be used as fertilizer. As a cooking fuel, biogas is superior to most other energy sources, for it can be controlled easily and its flame can be concentrated on the pot. Thus, the biogas stove efficiency is about four times greater than wood. In addition, biogas extraction and use have environmental advantages, including a smoke-free kitchen and methane that is burned instead of released into the atmosphere.[7]

5.57 Over the past 30 years, the Government of India has made significant investments in both research and promotion of biogas digesters. However, according to the six states surveyed, the highest rate of ownership of individual biogas plants is only about 7% of households in Maharashtra, and less than 2% in all other states, with many systems in various states of disrepair. One reason for this poor response is that the biogas program is tailored to middle- and upper-income farmers. For example, a biogas unit can cost US$700-1,000, and cannot be installed unless the farmer has three-to-four large animals.

Energy-efficient Electricity

5.58 While the main thrust of the power-sector policy has been to increase supplies, major opportunities remain to improve end-use efficiency in lighting, appliances, and agricultural pumping. Lighting is provided by kerosene, electricity, and, to a lesser extent, by oil lamps and flashlights. Both kerosene and electricity are used for lighting in most states. The annual consumption of kerosene for lighting is comparable to that of electricity in Andhra Pradesh, Himachal Pradesh, and Maharashtra, and is much higher in Rajasthan and West Bengal—the two states with the lowest percentage of electrified households.

5.59 Electricity has two advantages over kerosene for lighting. First, the quality and amount of light produced by electricity far surpass those of a kerosene lamp. (However, households with electricity connections use kerosene for lighting, either as a backup during frequent electricity outages and brown outs, or as a mobile source of light.) Second, electricity is more energy efficient than kerosene lighting. For example, Punjab consumes 40% less energy for lighting than does West Bengal, the poorest state, as most of Punjab's lighting is provided by electricity, while nearly 90% of West Bengal's lighting is derived from kerosene. Thus, the current subsidy for kerosene lighting in rural areas would be better targeted if it encouraged poor households to adopt electricity for lighting.

5.60 There are two types of electric lamps: incandescent bulbs and tube fluorescent lights. A tube fluorescent light or its twin, a compact fluorescent lamp, is about four times more efficient than an incandescent bulb (Table 5.4), and, under most conditions, the savings in electricity use more than compensates for the higher purchase price of the fluorescent tube.

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7 From a greenhouse gas perspective, methane has an adverse warming effect about 20 times that of CO_2. If dung is applied directly to rice fields, methane is released into the atmosphere. However, if dung is first passed through a digester and used for energy, the resultant slurry or waste still retains its fertilizer properties.

Table 5.4 Comparison of Non-electric and Electric Lamps

Light source	*Flux (lumens)*	*Color quality*	*Luminous efficiency (lumens/W)*	*Fuel consumption (Kg/lumen hr)*	*Fuel consumption rate (grams/hr)*
Candle	12	Excellent	0.2 [a]	0.5	6
Kerosene wick	40	Excellent	0.1	0.8	32
Kerosene mantle	400	Poor	0.8	0.1	40
Incandescent bulb (60 W)	730	Excellent	12	0.02 [b]	16
Compact fluorescent lamp (16 W)	900	Good	56	0.005	4

Note: The Color Rendering Index measures color.
[a] Assumes a fuel conversion efficiency from fuel to electricity of 0.
[b] Assumes a fuel conversion efficiency from fuel to electricity of 0.3.
Source: Dutt 1991.

5.61 Although the economics of fluorescent lights are decisively attractive on a systemic level, the advantages do not appear compelling to rural householders. At present, compact fluorescent or fluorescent bulbs represent only about one-tenth of total light bulbs in the villages surveyed. One reason for such low penetration is that compact fluorescent and fluorescent lamps involve a higher initial outlay than do incandescent bulbs, and perform less satisfactorily under conditions of fluctuating voltage. Also, subsidized electricity prices distort the economic calculation. Improvements in reliability of electricity supplies to rural areas and a more rational pricing system could lead to accelerated adoption of energy-efficient lighting technologies.

Appliances

5.62 One striking development in rural energy over the last generation has been the rapid increase in number of appliances. At least 12% of rural households now own small appliances, including radios, television sets, ceiling and table fans, and irons. Ownership is particularly high in Punjab, where higher incomes and 94% of electrified households support a saturation level of 79% for table fans, 158% for ceiling fans, 68% for television sets, and 26% for refrigerators. In Himachal Pradesh, householders display similar ownership levels, except for fans, since the cooler climate does not require their use. The biggest increase in appliance ownership has been for television sets, which rose from 1% in 1980 to 40% in 1996 in four states: Andhra Pradesh, Maharashtra, Punjab, and West Bengal.

5.63 . It can be confidently predicted that, with rising rural incomes, the trend toward higher appliance ownership will continue and even accelerate in the future, a finding that underscores the importance of appliance efficiency standards. For example, efficiency of the electric fan (one of the first appliances to be acquired) can be increased in two ways: by replacing the fan motor with a more efficient one or by replacing the conventional speed regulator with an electronic one. The motor option is cost effective if a new motor is installed at the time the fan is manufactured.[8] The electronic speed regulator reduces electricity consumption, but may increase

[8] Dutt (1991) reports a cost of conserved electricity of Rs. 0.40 /kWh for this option.

transmission and distribution line losses, so its net effect on the system power factor is unclear. Thus far, ownership of major appliances, such as large refrigerators, freezers, and air conditioners, is limited. Introducing high-efficiency standards for these items at an early stage could realize major savings at a later date. Again, the question of electricity pricing will play an important role in deciding which energy-efficiency path to choose.

Pumpsets

5.64 The third major rural energy end use is pumping ground water for irrigation, for which pumpsets are commonly used in many states. Government programs, of which the most influential has been the provision of highly subsidized electricity, have actively promoted the use of pumps. Some 500,000 electric pumpsets are added each year, and their electricity consumption is increasing twice as fast as that of overall electricity use. Diesel pumpsets are also widely used.

5.65 Although government programs have succeeded in promoting pumped irrigation, they exact high costs, and it is unclear whether they can be expanded substantially and sustainably. In some states, agriculture accounts for 30% or more of total electricity sales. Consequently, large subsidies put these states' SEBs in financial jeopardy. In addition, the provision of cheap or, in some cases, free electricity to farmers discourages efficient use.

Conclusion

5.66 This study's findings indicate that access to commercial energy has been strongly influenced by government policies. On the positive side, extensive participation by the government has demonstrated a commitment to providing better energy services in rural areas. India's rural electrification program has enabled many rural residents to acquire electricity for the first time, and the social and economic benefits are probably understated. The petroleum distribution program has extended enough kerosene for lighting to people in rural areas, who seem to take advantage of the program. In addition, the renewable energy program has made progress in the area of technology trials and pilot projects. Nevertheless, problems have plagued these programs.

5.67 Rural people have clearly expressed their concern that fuelwood supplies—and trees in general—are becoming scarcer. Although programs have been implemented to address these problems, most rural residents must fend for themselves when it comes to biomass and fuelwood issues. The social forestry programs of the last several decades have now been replaced by community forestry management schemes. Although helpful, such schemes usually are limited to areas that still have access to forests. In many cases, areas without forest access do not receive outside assistance.

5.68 Distribution of kerosene through the public distribution program has been beset with difficulties, including inadequate and unreliable supplies, as well as diversion of kerosene to diesel markets. Although many attempts have been made to alleviate these problems, such diversions usually create local scarcity, especially for poorer households. Though supplies of LPG to urban markets have greatly improved, rural areas do not enjoy the same access.

5.69 The quality of electricity supplies is poor, with an average of 90 power outages per month. Such poor performance by the SEBs can be traced to an incentive structure, imposed by federal and state agencies, that fails to serve rural populations, as evidenced by the price of electricity for agricultural pumping and household use. In short, the incentive structure provides subsidies designed to reach specific targets rather than to service rural people (Reddy et al. 1991).

5.70 India has a tremendous potential for improving the efficiency of pumpsets. Simple adjustments to existing pumpsets could achieve savings of 28% of the water pumped. If electricity were fully priced, these savings would be highly cost effective. At present, adjustments to diesel pumpsets achieve higher savings because the price of diesel is higher than that of electricity. Another potential source of savings is to improve the efficiency of the some 500,000 new pumpsets that are installed annually (Sant and Dixit 1996a, 1996b). However, in practice, farmers pay little or nothing for electricity, creating weak incentives to adjust pumpsets. The tariffs for agricultural pumping also are generally fixed at a certain level for an entire year. As a result, no matter how much energy farmers use, they pay the same price for it; thus, conserving electricity is not a concern.

5.71 The renewable energy program has had difficulty in promoting a more widespread adoption of technologies in rural areas. This ineffectiveness can be attributed, in part, to taking a targeted approach to technology dissemination rather than creating market conditions for promoting renewables and the failure of improved stove and biogas systems.

5.72 India's rural energy situation has greatly improved over the past several decades. Today's programs are commendable in terms of their efforts to bring rural populations into the modern era through providing essential services. Nonetheless, these programs could achieve more. In addition to the obvious need for better coordination between programs, individual programs, which reflect significant investments, could be more effective. Exploring ways in which to increase their effectiveness is the topic of the next chapter.

6

Policy Recommendations

6.1 India has been a developing world leader in addressing rural energy problems. Efforts of the country's various ministries involved in rural energy programs have yielded positive results. For example, the grid rural electrification program now covers nearly the entire country. The SEBs have received approximately Rs.1.4 trillion in financing from the Rural Electrification Corporation. Renewable energy has been afforded ministry status. In addition, biomass and forestry issues have been addressed through social forestry and local forestry management programs, the investments in which total several billion dollars.

6.2 The outcomes of these investments should not be minimized. India has risen from a food-importing country to a food-exporting country, largely because of the combined strength of irrigation and improved agricultural practices. Many rural residents now enjoy the benefits of modern lighting, fans, and televisions sets—conveniences that were unthinkable just 30 years ago. The renewable energy industry in India has grown significantly, including the more than 140 renewable energy firms identified in this study.

6.3 While massive investments in rural electrification have spurred development and an ability to pay among India's farmers and rural households, serious problems have emerged. Both the government and private sector must address a range of challenges, some of which are highlighted below:

- Although electrification has increased to more than 90%, households are connecting at a rate of only 40%.
- Rural villages experience about three power outages per day, with wide regional variation.
- LPG promotion in rural areas is virtually non-existent (there is evidence, however, that LPG use has increased significantly in Punjab and Himachal Pradesh).
- Kerosene distribution is biased toward urban areas (rural people can obtain only 4 l of rationed kerosene, while the limit for most urban residents is about 15 l).
- Fuelwood scarcity is resulting in increased commercial purchase of fuelwood and poorer households switching to lower-value cooking fuels, such as straw and dung.
- Renewable energy programs have reached few rural residents.

- The political process involved in electricity subsidies for agriculture has resulted in disproportionate subsidies for wealthier farmers.

6.4 The description of the markets and data on rural-energy use presented in the previous chapters provide the foundation for identifying both the problems of and opportunities for improving rural-energy access. In order to address many of the issues raised, a broader approach is required for both current and future programs. Although the challenges are many (TERI 2002), the multitude of existing programs reflects an ongoing commitment to tackle the problems involved in providing a reliable supply of energy to rural areas.

Development of Energy Markets

6.5 India's changing energy scene has been characterized in recent years by a trend toward liberalizing energy markets. Although the process has been slow and has far to go, positive market developments are expected to continue.

Electricity Policy Reforms: Challenges and Opportunities

6.6 As noted previously, the supply of electricity to rural areas is of poor quality and suffers from frequent interruptions. Sale to domestic consumers is metered but supplied at a rate that is subsidized relative to the cost of supply; sale to agricultural consumers is supplied at a fixed cost or is free of charge (World Bank 2001a). The fixed tariff is usually well below the cost of supply, although, in some drought-prone areas, it might be higher. The low electricity price is a disincentive to the use of efficient electric appliances and lighting.

6.7 To redress this situation, the Government of India has formed regulatory commissions at the central and state levels to seek higher tariffs in order to increase agricultural tariffs to at least half the cost of supply. The commissions will also permit independent power production and sale of electricity to the grid. In the near future, the development of local area grids will help improve electricity supply and use in rural areas.

6.8 Recent experiments by several states in electricity sector reform are likely to change the way electricity is generated and distributed in the country. For instance, Andhra Pradesh has started a 10-year reform process that includes a reorganization of the SEB and pricing policies for electricity. Of greatest relevance to rural households, the initial stage of the reform process will create two companies, one focused on generation and the other on transmission and distribution. One goal is a better focus on customer service through greater system efficiency and reliability.

6.9 However, in the near term, reforms will not solve the problems of rural electrification. In fact, based on evidence from other countries, the problems of poor households are often inadequately addressed through the reform process.

6.10 The electricity sector reforms presently being carried out by the Government of Andhra Pradesh, with World Bank assistance, aim at improving electricity service, which should directly benefit poor households, given that, as this study found, some poor households have electricity. However, the argument also is made that the financial resources freed up in the reform of the sector will benefit the poor. Such indirect benefits are no consolation to poor households facing rising electricity prices. Also, it is difficult to tell whether any avoided electricity subsidies are used in reducing poverty.

6.11 Consequently, it is recommended that special attention be given to ensure that poor households are not adversely affected by privatization or rising prices. This may be accomplished through social impact assessments carried out by the new transmission and distribution organizations involved in power-sector reform. The assessment's goal should be not only to avoid harm, but to recommend direct benefits to the poor. As this study indicates, poor households are suspicious of the reforms, and are also the group most likely to be negatively affected by increased electricity prices. Reforms could be accomplished in various ways, including lifeline rates or a fixed payment for minimal levels of service. In short, the focus should be on how electricity reforms can benefit the lives of poor rural people.[9]

Lessons from Successful Rural Electrification Programs

6.12 Smaller companies that concentrate solely on electricity distribution may be better able to address India's rural electrification problems, including low loads, low household-connection rates, subsidies for agricultural consumers, poor customer service, and inadequate bill collection. Today, many small rural electric cooperatives are recognized as providing somewhat better service than the SEBs within the same policy environment. Development of private, cooperative, or other types of rural electricity distribution companies is a worthwhile goal.

6.13 As restructuring of state power utilities gains momentum, appropriate institutional frameworks and incentives need to be created to ensure that rural electrification expands in ways that are sustainable. In implementing such reforms, it is essential to understand that they may play an important role in encouraging the development of smaller distribution businesses to serve rural areas. Thus, the reforms should not only focus on large companies, but should consider creating an environment in which smaller companies are encouraged to service rural markets.

6.14 Lessons from successful rural electrification programs indicate that both large and small companies must follow certain principles (Barnes and Foley 1998). In most countries, there are major opportunities for reducing construction and operating costs. For example, careful attention to system design can reduce construction costs by as much as 30%, contributing significantly to the program's pace and scope. Another key principle is reducing initial connection charges. Usually, rural families find the initial connection costs that the utility demands a far greater barrier to electrification than paying monthly electricity bills. Reducing initial charges or spreading payments over several years, even if it means charging more per unit of electricity, allows many more low-income, rural families to obtain a supply.

6.15 All successful rural electrification programs have developed their own systems for ranking or prioritizing areas for obtaining a supply. Capital investment costs, level of local contributions, numbers and density of consumers, and the likely demand for electricity are among

9 These issues are being addressed through some initial work within the World Bank (2001b) on power-sector reform and the poor.

the factors usually considered. The specific institutional structure, however, does not appear critical, as a variety of approaches have been successful.

6.16 Charging the right price allows the electricity company to provide a supply effectively, reliably, and sustainably to an increasing number of satisfied consumers. All successful programs have strongly emphasized covering their costs, despite the wide variation in how they approached the problem. Smaller, more flexible companies might encourage daytime use of electricity in rural commerce and industries, encourage more people to connect to the systems, involve local leaders in bill collection to lower costs, and provide flat rates for minimal service. Companies also would have an incentive to develop lower-cost system designs to provide service to low-demand consumers.

6.17 Given the many problems associated with rural electrification in India, one solution could be to encourage the development of community, regional, or private electricity distribution companies. While there is no ideal institutional structure for providing electricity service to rural people, development of private, community, or cooperative distribution companies that are more responsive to consumers could solve some existing problems associated with SEB service.

6.18 The question of low agricultural tariffs and other pricing problems, although still a contentious issue, may be more easily handled in smaller distribution companies. The study survey revealed that, while rural households are willing to pay for reliable electricity service, they distrust the SEBs. Initial programs could be located in regions with low agricultural loads to test the viability of the approach. In addition, local companies might be better able to deal with the pricing problem, since they would be located closer to their customers. For example, if residential customers understood that they were paying higher prices because of subsidies to agricultural pumping, they might have less resistance to reducing agricultural subsidies. Today, people have no understanding of how electricity prices are set, and many even believe they are being taxed for electricity.

6.19 The SEBs, no doubt, would welcome businesses taking over their unprofitable rural systems, especially those with significant numbers of agricultural consumers. However, incentives are not in place for encouraging the development of local electricity businesses, mainly because they must abide by the same pricing and distribution policies that are causing problems for the SEBs.

Redirection of Agricultural Subsidy

6.20 The agricultural subsidy has been found to benefit large farmers more than smaller ones. The total annual amount directed to agriculture in 1995-96 was estimated at US$4.1 billion (Government of India 1997). The agricultural subsidy has been at the core of many SEB problems (World Bank 2001a). This study found that farmers are willing to pay for electricity service. In fact, the value of the electricity subsidy can be as much as $US0.20 per kWh. (As indicated in the next section, there also is a widespread kerosene subsidy directed toward lighting in rural areas as part of the public distribution program.) Redirecting subsidies toward intensification of the grid in areas with electricity, combined with promoting development of markets for renewable energy in offgrid areas, would greatly enhance the electrification program's positive effects on the rural poor. Remaining unelectrified households, who generally are quite poor, would be well targeted with a program to intensify household use of electricity.

Decentralized Supply: Need for a Common Framework

6.21 India encourages the development of local electricity supplies through microhydro generation and other special programs. Where feasible, such distributed generation has the benefit of balancing loads and strengthening the distribution system. However, the incentives and regulations for developing local generation sources for rural distribution, with the exception of microhydro systems, have not been well developed (Reddy 1999). Entrepreneurs or communities generally construct such systems, the power from which could be sold to the grid or local distribution companies.

6.22 In addition to microhydro systems, decentralized generation could be based on gasifiers or biogas plants, in combination with wind or PV sources, to provide electricity for fluorescent lamps, high-efficiency irrigation pumpsets, and domestic water supply. Local woodlots and animal waste would feed the gasifiers and biogas plants. The Centre for Application of Science and Technology for Rural Areas (ASTRA) group at the Indian Institute of Science has demonstrated the technical and institutional feasibility of this concept in Pura, Ungra, and neighboring villages in Karnataka (Rajabapaiah, Jayakumar, and Reddy 1993). Some industries located in rural areas produce significant levels of biomass, which could be used as a fuel for generating electricity. For example, using current technology, bagasse from the sugarcane industry could be used to generate electricity for factories and local distribution.

6.23 The main problem with these potential projects is the low price of electricity in rural areas, combined with the restricted nature of the electricity business in most states, which stymies incentives for local generation and distribution. Instead of having a common framework for promoting decentralized generation and sale in rural areas, most states rely on a patchwork of rules and regulations to cover specific generation sources. For example, wind generation is eligible for various tax write-offs, while minihydro is not treated as favorably. Thus, rules and regulations for decentralized generation and sale in rural areas and to the grid system require further clarification and standardization.

Petroleum Products Availability

6.24 The system for retailing and distributing kerosene and LPG has greatly restricted rural access to these fuels. The survey indicates that, in rural areas, kerosene is available in limited quantities through the ration program, and LPG use is not prevalent because the network of LPG distributors focuses on urban areas. In the survey, the LPG market was larger than expected in wealthier states, but was generally unavailable in most rural areas. Wealthier rural households that can afford to cook with kerosene or LPG often lack access. This puts more pressure on locally available biomass supplies, leading to serious health and environmental consequences.

Rural Distribution of LPG

6.25 Evidence from this study suggests that more rural people would use LPG if the fuel were readily available in rural areas. The survey indicates that LPG use is quite high in Himachal Pradesh, a state in which LPG restrictions have been reduced to encourage rural sales to reduce pressures on local forests. Although it is uncertain whether the rate of deforestation has been affected, many rural people are using LPG for cooking.

6.26 The structure of private entry for providing LPG for sale in rural areas is now in place. Under the current system, government retailers continue to provide subsidies for existing, mainly urban, consumers. The private sector is now allowed to import and sell LPG at market rates, which presently are above those of government retailers. However, private-sector sale of LPG is limited to about 1% of the total market. It is anticipated that the difference between private-sector and government-retailed LPG will gradually be phased out, and the market share of the private retailers will increase. However, given the political nature of this subsidy, this scenario cannot be guaranteed. In practice, government retailers have a significant advantage over private retailers (World Bank 2002). Thus, LPG subsidies go mostly to well-off urban consumers.

6.27 It is recommended that liberalization of LPG retailing and elimination of disincentives to expanding service in rural areas continue. One option would be to sell LPG in smaller bottles (World Bank 2002), which rural people would be more likely to purchase, given that they only use small quantities to help meet their cooking needs.

Need To Redirect Subsidies

6.28 The survey found that the kerosene subsidy, aimed squarely at the lighting market, is reaching poor rural households; however, the subsidy policy is outdated, having been formulated at a time when electricity was unavailable. Moreover, many problems are associated with kerosene being diverted for use as diesel fuel.

6.29 India is now at a stage where higher-income households have access to and use electricity in their daily lives. Although serving a higher percentage of a predominantly poor, rural population involves significant technical challenges, substantial infrastructure investments are already in place. Given the appropriateness of targeting subsidies to poor populations, a more suitable policy would be to redirect the kerosene subsidy to intensify and improve the quality of rural electricity service. The benefits of switching from kerosene to electricity for lighting are so great that such a policy would have a far greater effect than the kerosene subsidy and would more effectively reach the target population. This objective could be achieved through grid intensification and promotion and through marketing of renewable energy systems for rural areas. In addition, the electricity subsidy that targets the agricultural sector could be redirected toward improving service in rural areas, which would benefit all rural populations. However, this could only be accomplished by improving system reliability and rural service.

Meeting Biomass Demand

6.30 Biomass—by far, the most widely used form of renewable energy in rural India today—is inexpensive to use, convenient to store, and readily available. The survey of rural energy consumption has shown that rural people will likely continue using biomass fuels in the foreseeable future. Major advantages are that it can be grown close to its demand center and, when appropriately managed, is renewable. Thus, policymakers should aim to ensure an available, economic, and sustainable supply of biomass energy to meet the demands of individual centers and industries, and ensure that it be used efficiently in smoke-free surroundings.

6.31 In four out of the six states surveyed, estimated wood demand for household energy was greater than estimated sustainable supply. These shortages were also confirmed by the study surveys, in which more than 90% of households agreed that fuelwood was in short supply. The study found that the most severe shortages were in West Bengal, where nearly all grain residues and half the dung from large animals were used for household fuel. In addition, this state had the largest per-capita consumption of purchased cooking fuels, including charcoal, mineral coal, and kerosene. Such findings point to the compelling need to conduct proper, timely inventories, especially for trees grown outside the forest, as well as for crop residues and dung.

Continued Emphasis on Joint Forest Management

6.32 The World Bank has six ongoing, state forestry projects and two national ones. The state projects are located in Andhra Pradesh, Maharashtra, West Bengal, Kerala, Madhya Pradesh, and Uttar Pradesh (Lele 1999). The Bank's forestry projects incorporate the joint forest management policy promulgated in 1988. This approach, which stressed development through conservation, called for distributing forest resources to the rural poor living in or near forest areas in return for their participation in forest management and protection. In part, success of each project depends on the respective state's degree of commitment. Above all, it depends on the efforts of forestry personnel to work with and on behalf of rural people rather than through dictates. In states with highly dedicated forestry personnel, such as Andhra Pradesh and Madhya Pradesh, such projects are more successful than in states like Maharashtra.

6.33 Joint forestry management programs—which aim to extend forested area, improve forest cover, increase the mix of plant and animal species, and enhance their quality through various programs—target the most disadvantaged rural groups living in marginal areas, usually under some form of tree or scrub cover. To date, these programs have focused mainly on enhancing tree stock, rather than managing forests for increased goods and services. The Bank has supported these efforts through funding, training, management, promoting behavioral changes within forestry departments, village capacity-building, technological innovations, and advocating the sustainability concept.

Managing Trees Outside Forests

6.34 The joint forest management program described above is directed toward villages that reside in or near forests. However, as noted previously, most villages in India are not located near forests, and many of these are experiencing fuelwood shortages. In the past, social forestry programs attempted to address this problem by recommending that the forestry department plant trees along roadsides and on other public lands and that villages develop woodlots on common land. The woodlot development ran into trouble early in the program, and the social forestry programs were criticized for recommending single-species plantings.

6.35 This study indicates that rural people are switching to kerosene and LPG for cooking, spending about one hour per day collecting fuelwood, and are purchasing fuelwood at local markets. This behavior pattern would suggest that many regions in rural India are poised for programs that involve management of trees outside forests. The so-called wastelands of rural India are the source of many useful products, including fodder and wood. Many farmers own land on which they could plant trees for poles and local fuelwood use. Thus, it would be possible to design programs similar to joint forestry management programs on nonforested land. Since not all regions suffer from fuelwood shortages, any programs aimed at managing trees outside the forests should be directed toward those areas with the greatest fuelwood shortages.

Local Resource Assessments

6.36 Meaningful policies cannot be formulated unless the resource situation is clearly understood. This is particularly so with biomass energy because it has to be available near to where it is consumed. Thus, a priority for any energy strategy is to assess the existing fuel supplies, and, in the case of woody biomass, stock and sustainable yield. As most biomass resources have multiple uses, their end-use demand should be tabulated and compared with supply. Therefore, biomass resource assessment should be a priority for diagnosing whether low levels of wood supply are a significant problem for rural India.

Biomass Cooking Using Improved Chulhas

6.37 Using biomass in traditional ways for cooking can pose health problems for rural households. The household surveys in this study illustrate that cooking often involves using inefficient stoves without chimneys in poorly ventilated kitchens. This causes severe indoor air pollution, with exposure to particulates and carbon monoxide. The surveys also reveal that government programs to promote the use of efficient stoves have been ineffective, as evidenced by the minimal saturation of these stoves in the surveyed villages. Also, a recent investigation by the World Bank (2002) on the improved stoves program indicates that success is possible, as certain states have programs that have performed better than others.

6.38 The Appropriate Rural Technology Institute (ARTI) (formerly known as the Centre for Application of Science and Technology for Rural Development [CASTFORD]), a Pune-based NGO, has developed several innovative approaches that are now being applied elsewhere in the country. These include 1) use of easy-to-assemble portable molds for making improved chulhas, 2) setting up an entrepreneurship development program for potters, and 3) training potters in the installation of community chulhas. The ARTI approach promotes improved chulha technology as an income-generating opportunity for rural potters. Rural householders find that potters' claims are more convincing than those of government officials or NGOs and that entrepreneurial potters are more capable than targeted government programs in delivering improved stoves (Hanbar 1993; Karve 1993; Karve 1999).

6.39 ARTI has developed standardized molds for three types of improved chulhas, which are purchased by the district governments and provided to the ARTI-trained potters. Some potters who receive entrepreneurial training set up their own manufacturing workshops and can earn an annual revenue of US$2,500-5,000, about 10 times the national per-capita income. The

ARTI program has been commercially successful in rural areas where households are accustomed to a cash economy and commercial applications (Karve and Hanbar 1996).

6.40 What makes the ARTI program a success is that government and NGO involvement are limited to areas where they can contribute most, such as research and development of improved stoves, demonstration and dissemination of molds (not the stoves themselves), training of potters, and information dissemination. The construction and sale of stoves are left up to the potters, who are most familiar with their markets and thus can apply appropriate sales techniques.

6.41 Independently, the ARTI program has adopted techniques recognized as best practices in the development of improved biomass stove programs. The world's largest program is located in China, where standardized stove inserts are used to lower costs and ensure the quality of improved stoves.

6.42 In overall performance, India's improved stove program—the second largest in the world—fell short of the best international practice; nonetheless, the program has achieved positive results in many locations from which useful lessons can be drawn (World Bank 2002). These include emphasizing smoke removal and health benefits; commercialization at the state level; collaboration between designers, manufacturers, and consumers; role of national-level coordination; and the need for new strategies to reach the poorest households.

Evolution of a Renewable Energy Approach

6.43 As indicated throughout this report, with the exception of improved stoves and, to a limited extent, the biogas program, there is little evidence that renewable energy plays a significant role in India's rural energy situation. Rural people do not own and are largely unaware of various renewable energy devices. Within this context, the government program for the promotion and dissemination of renewable energy has been oriented toward pilot projects, dissemination targets, and direct subsidies (Ramana 1998). In the early stages of product development, pilot projects were justifiable for testing new technologies. Today, however, most renewable energy technologies have moved beyond the testing phase. It is therefore recommended that programs move toward supporting market development.[10]

From Pilot and Target Programs to Market Development

6.44 It is recommended that the extensive knowledge gained from the development of pilot projects be applied to promoting market development of renewable technologies. This approach could support activities that focus on market development, rather than specific technologies. For example, quality-assurance standards could be developed for various types of systems. This would mean development of laboratories for testing products, as well as surveying households with systems to determine preferred features.

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10 One notable exception is the wind-energy program; however, it is intended for central-power generation and is not closely related to rural energy.

6.45 The broad approach to disseminating renewable energy technologies should be replaced by an approach that focuses on niche markets for products. At present, little market-segment identification is occurring, even by major manufacturers, who are selling more of their products to the government than to consumers. Thus, the technologies are designed according to government standards rather than consumer tastes.

6.46 Presently, the playing field for renewable energy technologies is not level. Rules and regulations differ by type of device. For example, solar water heaters receive a different type of susbidy than do biogas or bagasse cogeneration systems. Based on many conversations with villagers, community leaders, and manufacturers, nothing will damage markets for renewable energy systems faster than the possibility that rural people in the designated areas can obtain a discount from a government program. The government, therefore, can play a major role in simplifying and clarifying the rules and regulations surrounding renewable energy systems. Although perhaps difficult to implement, it is recommended that renewable energy be treated like more typical energy sources, such as grid electrification and petroleum products. Finally, it should be stressed that matching the subsidies of other programs will not level the playing field for renewable energy.

Broadening the Scope of Businesses

6.47 Success of India's renewable energy programs will be measured by the extent to which the industry commercializes and develops retail markets for its products. Even though the rural electrification industry is in its infancy, many businesses are involved.

6.48 From the outset, World Bank programs have aimed at developing commercial businesses for renewable energy. These programs have included large wind, microhydro development, and household PV systems. However, the approach has been to advance specific technologies to be supported by special programs. For example, support has been given to large wind (but not small wind) for a local community.

6.49 Since this study considers renewable energy within a rural context, it is recommended that the scope of support for related business development be broadened. This has already begun in the case of renewable energy projects. The PV component of the projects is supporting NGOs and fee-for-service providers of PV systems. In the Indian context, the most appropriate model is to provide technical assistance, loans, and other support to communities, cooperatives, NGOs, and other groups willing to provide rural people energy services.

6.50 This support is already taking shape, although in a somewhat bureaucratic way. The organization develops a financially sustainable business plan to develop renewable energy or to provide renewable energy services to rural residents. The requirements for this type of approach involve technical assistance, a lender willing to approve loans, and loan supervision. Subsidies can be provided for technical assistance, but not for the businesses themselves, which should be self-sustaining. The government should be involved in assisting industry and retailers in information exchange, in the form of conferences, seminars, and publications.

Remote Regions Lacking Grid Access

6.51 The poorest households, who spend little on energy for lighting and other energy services, are unlikely to adopt renewable energy systems. The high costs of these systems are more appropriate for people living in remote areas, where the cost of grid extension of electricity is prohibitively high. In such regions, subsidies are essential to support the widespread adoption of electricity service that is based on renewable energy. However, as indicated previously, such subsidies should be structured to support the market development of renewable energy.

Policies To Benefit Poor Rural Households

6.52 In India, poor rural people are often the last to gain access to energy services. As Chapter 3 explained, they are even moving down the energy ladder, switching from fuelwood to straw and dung for cooking. Thus, it is especially important to consider how to promote poor rural households' access to energy services.

Electricity and the Poor

6.53 India's grid electrification program has succeeded remarkably in extending lines to rural people and promoting agricultural development. However, program implementation has been uneven. The problems experienced by poor rural households in adopting electricity are illustrated in the six states surveyed. In Punjab and Himachal Pradesh, more than 90% of households have adopted electricity; in Maharashtra and Andhra Pradesh, about 60% have electricity; and, in Rajasthan and West Bengal, adoption levels are 23% and 34%, respectively.

Lower Access Barriers to Electricity

6.54 The main populations who lack electricity are agricultural laborers, non-agricultural laborers, and marginal farm workers—all low-income classes. The two major reasons these households gave for not adopting electricity are that the deposit for service and the monthly charges are too high. Since many of these householders are migrant workers who move according to the agricultural seasons, they do not want to pay for maintaining electricity service when they are away from their home village for extended periods of time. Within the six states surveyed, 10-40% of households said that they are "awaiting a connection."

6.55 Unelectrified households use kerosene for lighting, typically 4-6 l per month, at a cost of Rs.14-20. In Andhra Pradesh, the cost of minimal electricity service, regardless of level of use, is Rs.25, which covers the first 30 kWh per month. By contrast, Punjab has a modest "meter rent" at about Rs.1.5 per month, and Himachal Pradesh has a monthly charge of Rs.4. It is no coincidence that Punjab and Himachal Pradesh also reach more than 90% of rural consumers. From the perspective of poor households, the fixed charges for electricity are a significant barrier (perhaps more so than the kilowatt-hour charges) to adoption of service. Because poor households use so little electricity, the fixed charges may be more significant than price in deciding whether to take a connection.

6.56 Three recommendations are suggested for encouraging poor households to adopt electricity. The first involves redirecting the kerosene lighting subsidy to poor households. As indicated previously, poor households currently receive a subsidy for lighting with kerosene. But the light from a kerosene lamp is vastly inferior to electric lighting. A kerosene lamp dimly illuminates the interior of a house, preventing family members from reading or participating in social activities. Ideally, the kerosene lighting subsidy could be redirected as a credit or coupon to allow poor households to adopt electricity.

6.57 Second, since poor rural households generally use less that 20 kWh of electricity per month, a special lifeline rate of 10-15 kWh per month (enough to power two light bulbs and a radio or a black-and-white television) could be established. This small amount would not adversely affect any electricity company, as it could easily be recovered through cross-subsidies. However, a lifeline rate would greatly improve a poor rural household's quality of life. To encourage poor households to adopt electricity, it is recommended that the upfront costs, both financial and "hassle" costs, be lowered. Because of seasonal incomes, low fixed monthly costs are advised. If poor households have no income for a particular period of time, they can refrain from using electricity and will not be charged for it.

6.58 Third, technical design innovations need to be developed for poor households. Low-cost distribution methods could be developed and associated with the lifeline rate and low-service initiation fees. This would further reduce the costs of servicing this group of consumers by electricity companies. Such low standards of service, already in place in many rural areas, are known as "illegal connections." The idea would be to eliminate substandard, illegal service by lowering costs to a level that poor households could afford.

Need for Reforms To Address Rural Poor Directly

6.59 In most sector reforms, the goal is to improve service and privatize the sector, without much thought given as to how such actions will directly affect the rural poor. Promotion of electricity-sector reforms has focused mainly on the prospect of breaking up the electricity companies into distribution, transmission, and generation companies within a regulatory framework. The issue of rural and poor people's access to electricity after reforms are in place has not been directly addressed. Instead, this is considered a second-order, potential problem to be studied to determine the negative or positive effects of the reforms. Rather than considering poor rural access a second-order problem, the reforms should address the issue directly (World Bank 2001b).

6.60 While it is true that unreliable service and target-driven approaches often adversely affect poor householders, public programs have an explicit obligation to serve them. This obligation is not explicit for the private sector, which is more profit driven. Thus, privatization should be accompanied by explicit incentives or regulations that address electricity access by poor households. In India, where electricity lines extend in nearly all directions, the simple act of switching from a kerosene lantern to electric lighting can tremendously benefit a poor rural household.

Urban Bias of Cooking-fuel Policies

6.61 Indoor air pollution is estimated to account for about 500,000 premature deaths annually in India. Those most affected are rural and poor people. In the larger urban areas, residents have made the switch to cleaner burning fuels, such as LPG and kerosene. In fact, past government policies have favored urban distribution of both kerosene and LPG. This was the case in Hyderabad, where, from 1980 to 1994, most poor households switched from wood to either kerosene or LPG to meet most of their cooking needs. In poor rural areas, indoor air pollution problems can be addressed through the use of improved biomass stoves, greater use of kerosene and LPG, and relocating cooking outdoors.

6.62 The households still using biomass for cooking are the very poorest urban households and most rural people. This study found that rural people spend significant amounts of time collecting biomass. Rural residents believe there is a growing scarcity of quality fuelwood, a perception supported by state biomass supply trends. Solving these problems involves growing more wood for local use; burning wood more efficiently using improved biomass stoves; and using substitute fuels, such as kerosene and LPG.

Kerosene Ration Program

6.63 The kerosene ration program is administered through the Public Distribution System. As stated throughout this report, for urban families, the ration is 15 l per month, while the rural ration is only 4 l per month. In the past, kerosene outside of the Public Distribution System was available only on the black market. After much debate, the market for kerosene is now being liberalized, and private-sector retailers are now permitted to sell kerosene on the open market at world market prices. In practice, there is a two-tier system, with rationed kerosene sold at Rs.3-4 per l and market kerosene sold at Rs.7-9 per l. The implication of the above policies is that kerosene is used for cooking in urban areas, and, if not diverted to the diesel market, used mainly for lighting in rural areas. In other words, in rural areas, cooking with kerosene is discouraged.

6.64 A recent study on urban India recommended that kerosene be sold at retail prices in the market and that coupons or vouchers be issued to the poorest households to entitle them to purchase kerosene at discounted prices (ESMAP 1999). Such an approach is being tested in certain cities in India. Given that the kerosene subsidy does reach poor rural households and that many people depend on it for lighting, a similar approach could be followed in rural areas. However, it is essential that the bias toward urban areas for kerosene distribution be eliminated. Based on recommendations in the previous section, one option would be to provide kerosene vouchers that could be used either for purchasing kerosene from private retailers or as a credit toward installing a low-cost electricity connection for household lighting. An additional benefit of such a program would be that electrified households would tend to reduce their biomass fuel consumption, probably because they could do most of their cooking in the evenings before mealtimes.

LPG and Rural Households

6.65 In the near future, India's poorest households will not use LPG in great quantities for cooking. The factors working against using LPG for cooking include high front-end costs of cooking equipment and storage bottles (the standard 12-15 kg LPG bottle) and lack of a developed distribution network in rural areas. Historically, LPG has been in short supply in India, with thousands on the waiting list in urban areas. Thus, government retailers lack the incentive to extend service to rural areas, especially in light of the low incomes and smaller market for cooking.

6.66 The recommendation has already been made to liberalize the sale of LPG in rural areas. In addition, LPG could be made more affordable to a wider range of people by spreading out payments over time to reduce the initial costs of stoves to consumers. Also, the fuel could be sold in a wider range of bottle sizes to alleviate problems people have in making cash payments.

6.67 For those wishing to promote the use of LPG by the poor, a recent evaluation of the scheme for distributing LPG in rural areas offers a number of lessons (World Bank 2002). The economics of, and potential market for, LPG service should be assessed. The relatively high operating cost of LPG service (cylinder refill cost) may make it difficult to develop an effective subsidy scheme for the poor that is fiscally sustainable and supports the establishment of commercially viable businesses.

6.68 Rather than making the program universally available, the focus could be on those areas where availability of free or cheap biomass is diminishing. This would mean directing limited state financial resources to households that are hard-pressed to meet daily energy needs and are more likely to consume significant amounts of LPG. It is important to create a sufficiently level playing field for all LPG distributors, including private companies, in the spirit of sector deregulation and its ultimate objective of providing better service at lowest cost. Finally, the health benefits of reducing exposure to indoor air pollution should be publicized to increase demand for cleaner cooking. Such public-education campaigns should, however, be conducted within a broader context that emphasizes a number of measures, including smokeless chulhas and separate kitchens, so that households can choose from several options.

6.69 Adopting these recommendations would directly affect relatively wealthy rural households, as evidenced by the expansion of LPG use in Himachal Pradesh. However, given the shortages of quality biomass energy in rural areas, decreasing pressure on common lands would likely free up biomass resources for poor households as well.

Key Role for Improved Biomass Stoves

6.70 Improved biomass stoves have been designed with the aim of increasing energy efficiency and reducing indoor air pollution. Although these two goals are not always compatible, a multitude of designs accommodating various types of end uses and cooking styles can be developed. Given the evidence emerging regarding the harmful effects of cooking smoke on human health, the improved biomass stove can serve as an important bridge to using more convenient fuels in the future.

6.71 Properly designed, improved stoves that take local people's expressed needs into account can benefit human health; the environment; and use of time, particularly that of poor rural women, who typically work in the fields during the day, returning home in the evening to prepare food. In Himachal Pradesh, for instance, a stove costing about Rs.500 was designed with a water pipe running through it in response to the local community's desire for a stove that heated water. This example shows that no single design can serve all the diverse cooking needs and habits of rural people.

6.72 With appropriate technical assistance, however, a wider variety of improved stoves can be developed to meet the many needs of rural households. Such programs do not require huge investments, but can have a positive effect on time-use efficiency, quality of the indoor environment, and sustainability of local resources.

Summary and Final Thoughts

6.73 The Government of India's active support of rural energy involves a variety of ministries. In just 20 years, the rural electrification program has grown from serving only 43% of villages to more than 90%. Renewable or non-conventional energy has been upgraded to the level of a ministry. The Ministry of Forestry has adopted the joint forestry management program as a model for preserving the country's forests. And the Public Distribution System successfully sells subsidized kerosene through authorized retailers to villagers throughout India.

6.74 However, many rural energy problems remain. Despite reaching over 90% of villages, grid electrification in India reaches only about 40% of rural households. In many regions, rural households perceive local shortages of quality cooking fuels as a significant problem. Nine out of 10 people believe there is a fuelwood shortage that will continue well into the future. The sale of kerosene in rural areas has been limited to quantities needed for household lighting. In addition, the sale of LPG for cooking in rural areas has been actively discouraged. At the same time, indoor air pollution from cooking smoke is increasingly recognized as a significant problem. A realistic solution—the improved biomass stove—has achieved only partial success. Despite having a ministry in charge of renewable energy, the improved stove's penetration into rural areas has been slow because of the pilot nature of most programs.

6.75 The Government of India is committed to improving energy services in rural areas, as evidenced by the progress made to date. The cross-sectoral nature of the problems, however, complicates solutions. Household cooking decisions, for example, are influenced by issues that cut across forestry, petroleum, and non-conventional energy ministries. Moreover, energy is a key component of social development programs, including water, health, and education. Although the problems may appear daunting, they are not intractable. Many good programs exist, and India's dedicated government, NGOs, and other institutions are capable of tackling the problems and are willing to do so.

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Appendix: Methodology and Sample Design

1. The primary surveys were conducted to provide detailed information on rural energy use in India. In addition, the study sought to understand developmental changes in rural India. Consequently, the sample villages covered in the survey included 132 villages in the states of Andhra Pradesh, Maharashtra, Punjab, and West Bengal. Because these villages had been surveyed in 1983 within the context of the Social Soundness of Rural Electrification study, it was possible to examine changes in rural energy development over time, as well as differences between villages. Two additional states, Himachal Pradesh and Rajasthan, were included in the survey, which significantly extended the scope and geographic coverage to mountainous and arid regions. Forty-eight villages from these two states were sampled.

2. For survey purposes, a set of structured schedules was developed key rural energy and development issues. The data generated from the schedules administered are presented in Table A-1 below.

Table A-1 Primary Survey Coverage

Survey No.	*Survey Instrument*	*Respondents*	*Data Generated*
1	Census Schedule	All households in the village	Caste, occupation, electrification status, major domestic fuels used, ownership of NRSE devices
2	Household Schedule	Random selection of 28-30 households	Occupation, caste, literacy, income, sources of income, fuels used, quantum of consumption, source of procurement, % purchased/sold, energy used in agriculture, commercial establishments, opinions on energy problems, attitudes towards NRSE, average time-chart of women
3	Artisans Schedule	Artisan households	Type of artisanal activity, number of members engaged, women and child labor, energy forms used and quantum evolved, opinions on energy problems, governmental interventions
4	Rural Industries Schedule	Rural industrial units	Type of rural industry, manpower used, energy used, opinions and attitudes toward energy issues and problems
5	Village Opinion Leader Schedule	Selected village leaders	Opinions and attitudes toward energy issues and renewable devices
6	Individual NRSE Schedule	Households owning NRSE devices	Type of device owned, cost paid, opinion on benefits, problems and constraints faced in use of NRSE technology
7	Measurements of dung output and fuelwood consumed	Selected 8-10 households	Volume/quantity of fuelwood consumed and dung output per animal

3. Focus-group discussions were conducted in each of the villages surveyed to gain a better understanding of the practical issues pertaining to rural energy and development. These groups yielded more qualitative information on rural energy issues.

Sample Structure

4. India is a vastly diverse country, with a multiplicity of climatically resource-wise social practices and levels of awareness. Therefore, it was important that the study have a broad scope so that issues and programs could be examined within a wide variety of contexts. The six states selected (Andhra Pradesh, Himachal Pradesh, Maharashtra, Punjab, Rajasthan, and West Bengal) represented such diversity, as well as a wide geographical spread. In each of these states,

districts were selected that represented this diversity; a total of 180 villages, extensively spread across the six states, were surveyed (Table A-2).

Table A-2 States and Districts in the Study

State	*District*	*No. of Villages*	*No. of Households*
Andhra Pradesh	Kurnool	12	326
	Adilabad	12	317
	West Godavari	12	329
Himachal Pradesh	Kangra	8	224
	Shimla	8	223
	Kinnaur	8	225
Maharashtra	Bhandara	12	359
	Yeotmal	12	356
	Nasik	4	118
	Sangli	8	237
Punjab	Ludhiana	12	325
	Hoshiarpur	12	325
Rajasthan	Udaipur	8	235
	Bikaner	8	237
	Bharatpur	8	240
West Bengal	West Dinajpur	12	324
	Birbhum	12	324
	Barddhaman	12	324
Total		180	5,048

Source: ORG Survey, 1996.

5. In Himachal Pradesh, three districts were selected to maximize the diversity of the sample (Kangra, Shimla, and Kinnaur). Kangra is a plain region with a well-developed agricultural sector. Shimla, located in the mid-hills region, is noted for its cultivation of apples, hops, and other crops; however, the state's hilly terrain prohibits use of modern agricultural practices and equipment, such as tractors and pumpsets. Kinnaur is located along the upper reaches of the state. The selection of blocks was decided by the state Energy Nodal Agency (HIMURJA). Within the blocks, villages were randomly selected.

6. In Rajasthan, three districts were selected to represent the southern, westen-arid, and eastern-plain regions (Udaipur, Bikaner, and Bharatpur). Udaipur is characterized by low net sown area, low female literacy, and low agricultural labor productivity. Udaipur also has greater forest cover and higher tribal populations. Bikaner is relatively better endowed than many other

districts in the state. The Indira Gandhi Nahar Pariyojana irrigation project has resulted in significant socioeconomic changes, especially over the last decade. Bharatpur, an agriculturally developed district located in the eastern plains of Rajasthan, contrasts sharply with the desert conditions typical of the rest of the state.

Survey Instruments

7. Several types of survey instruments were developed for the study. In order to draw a random selection of households within villages, the team conducted a short census of all households in the villages. Research instruments ranged from a household survey to measurements of typical fuelwood measures, to village opinion leader surveys (Table A-3).

Table A-3 Survey Instruments

Survey No.	*Survey Type*	*Respondent Coverage Rate per Village*	*Total No. Respondents Surveyed*
1	Census	All households in village	52,773
2	Household	Random selection of 28-30 households per village	5,048
3	Artisans	All artisans in village	652
4	Industries	All rural industries in village	280
5	NRSE technology	All households owning NRSE technologies	1,476
6	Measurements of dung and fuelwood consumption	Selective sampling of 6-10 households per village	1,621
7	Village opinion leader survey	Four opinion leaders per village	715
8	Village schedule	One schedule per village	180

Source: ORG Household Survey, 1996.

Secondary Data Collection

8. In addition to the primary surveys, extensive secondary data was collected from available publications and government records (Table A-4). Relevant information was also collected from the literature available through newspaper clippings, ORG reports, World Bank publications and working papers, and other sources. The data thus collected were compiled and synthesized to arrive at a broad understanding of macro-level issues pertaining to rural energy and markets.

Table A-4 Secondary Data Collection

Survey No.	*Database*	*Information*	*Data Source*
1	Agro-climatic regionalization	Agro-climatic regions Districts located in agro-climatic regions Physiographic characteristics	Agro-climatic Regional Unit (ARPU) (Ahmedabad) working papers
2	Physiographic characteristics	Topography Rainfall Rivers Soil Climate Drainage	1996 Manorama Yearbook (published by Malayala Manorama), ARPU working papers
3	Demographic factors	Population Sex ratio Schedule caste/tribe distribution Population density Literacy Female literacy Worker classification	1991 census (compiled by National Informatics Centre)
4	Agriculture	Land-use pattern Cropping pattern Irrigation intensity	Directorate of Economics and Statistics of respective states
5	Infrastructure	Approach roads Railway stations/bus-stop facilities Communication facilities Schools Health facilities Electrification (by purpose)	1991 census, Directorate of Economics and Statistics of respective states, Literature review
6	Energy inventory	Biomass fuels Petroleum products Electricity generation Coal reserves	CMIE, TERI Energy Data Directory and Yearbook, Annual reports of respective ministries
7	Policy issues	Policy issues	Annual reports of respective ministries
8	Nonconventional energy installations	Types of NRSE technologies No. of NRSE devices installed NRSE programs being implemented	Respective state energy nodal agencies, CMIE, TERI Energy Data Directory and Yearbook

9. The level of effort expended on the survey provided a detailed and comprehensive database for the rural energy study. The combination of both cross-sectional and over-time data provided the basis for the study's analysis and findings.

HOUSEHOLD SCHEDULE

INDIA RURAL ENERGY STUDY

Project Code [W B] [H S]

State : ____________________ [ ]

District : ____________________ [ ]

Block : ____________________ [ ]

Village ____________________ [ ]

Household Serial No.. ____________________ [ ][ ][ ][ ]

Name of head of household : ____________________

ID Household : ____________________ [ ][ ][ ][ ][ ][ ][ ][ ]

Study Sponsored by

The World Bank, Washington, D.C

Name of the Investigator : ____________________

Date : ____________________

Verified by : ____________________

OPERATIONS RESEARCH GROUP
Baroda 1995

ID Household

RURAL ENERGY STUDY
HOUSEHOLD SCHEDULE

Q 1.0	**Identification**		
Q 1.1	State :_______________	Q 1.1	☐
Q 1.2	District :_______________	Q 1.2	☐
Q 1.3	Tehsil/Taluka/Block :________	Q 1.3	☐
Q 1.4	Village :_______________	Q 1 4	☐
Q 1.5	Household Serial No.:________	Q ..5	☐☐☐☐
PART A : SOCIO-ECONOMIC INFORMATION			
SE 1	Name of the respondent :_______________	SE 1	
SE 2	Name of the Head of household :_______________	SE 2	
SE 2.1	Sex (Code 1-male, 2-Female)	SE 2.1	☐
SE 2.2	Age :___________ Years	SE 2.2	☐☐
SE 2.3	Any position held in the village :_______________	SE 2.3	
SE 2.4	Land cultivated, if any		
SE 2.4.1	Total :___________ ha.	SE 2.4 1	☐☐
SE 2.4.2	Irrigated ___________ ha	SE 2.4.2	☐☐
SE 2.5	Category of household :_______ 1. Large Farmer (>3 ha.) 2. Medium Farmer (2-3 ha.) 3. Small Farmer (1-2 ha.) 4. Marginal Farmer (<1 ha.) 5. Agricultural Labourer 6. Non-agricultural Labourer 7. Artisan (specify) 8. Other (serivce, business, etc.)	SE 2.5	☐
SE 2.6	Caste : 1. S/C 2.S/T 3. OBC 4.Other	SE 2.6	☐

ID Household ☐☐☐☐☐☐☐☐

	Demographic Information			
SE 3	Number of persons eat and sleep in your household :			
SE 3.1	Male members (16-65)	SE 3.1		☐
SE 3.2	Female members (16-65)	SE 3.2		☐
SE 3.3	Male children (Under 15)	SE 3.3		☐
SE 3.4	Female children (Under 15)	SE 3.4		☐
SE 3.5	Adult members above 65	SE 3.5		☐
SE 3.6	Total family members	SE 3.6		☐☐
SE 3.7	Others (servants, etc.)	SE 3.7		☐
SE 4	Educational level :-			
SE 4.1	Total literates in family (6 years+)	SE 4.1		☐
SE 4.2	Highest level of academic education in family Education Code : 0. Illiterate 1. Literate but no formal schooling 2. Primary (1 to 4 std.) 3. Middle (5 to 7 std.) 4. High school (8 to 10 std.) 5. Higher Secondary (11 & 12 std.) 6. Graduate/LLB, B.Ed. MA, etc. 7. Technical (Dr., Engg., ITI Diploma, etc.)	SE 4.2		☐
SE 5	Housing Details			
SE 5.1	Number of houses owned	SE 5.1		☐
SE 5.2	Type of residential house : 1. Kutcha 2. Pucca 3. Mixed	SE 5.2		☐
SE 5.3	Ownership of the residential house 1. Owner occupied 2. Tenant 3. Other (Specify)	SE 5.3		☐

ID Household

SE 5.4	Types of roofing of the residential house (Kitchen) 1. Pucca (Concrete) 2. Tiles 3. Asbestos 4. Thatched 5. Tin 6. Other (Specify)	SE 5.4		
SE 5.5	Number of rooms in the house	SE 5.5		
SE 6	**Electrification :-**			
SE 6.1	House electrified (1-Yes, 0-No)	SE 6.1		
SE 6.2	If yes, when was house (not family) originally electrified? Year 19...	SE 6.2		
SE 7	**Domestic Water Supply Sources Used** Code : 1. Yes 0. No			
SE 7.1	Piped water (Central Supply)	SE 7.1		
SE 7.2	Well	SE 7.2		
SE 7.3	Tubewell/Borewell	SE 7.3		
SE 7.4	Tank	SE 7.4		
SE 7.5	River/Canal	SE 7.5		
SE 7.6	Handpump	SE 7.6		
SE 7.7	Others	SE 7.7		
SE 8	**Ownership of Assets**			
SE 8.1	Cooking Devices			

Sr. No.	Assets			Number (0-do not own)	Working status 0. Do not own 1. Working 2. Non-working
SE 8.1.1	Traditional Chulha	SE 8.1.1			
SE 8.1.2	Improved Chulha (Fixed)	SE 8.1.2			
SE 8.1 3	Improved Chulha (Portable)	SE 8.1.3			
SE 8.1.4	Sigri	SE 8.1.4			
SE 8.1.5	Improved Kerosene Stove	SE 8 1.5			

ID Household

SE 8.1.6	Solar Cooker	SE 8.1.6		☐	☐
SE 8.1.7	Biogas stove (single burner)	SE 8.1.7		☐	☐
SE 8.1.8	Biogas stove (double burner)	SE 8.1.8		☐	☐
SE 8.1.9	LPG Stove (single burner)	SE 8.1.9		☐	☐
SE 8.1.10	LPG stove (double burner)	SE 8.1.10		☐	☐
SE 8.1.11	Pressure Cooker	SE 8.1.11		☐	☐
SE 8.1.12	Electric Stove	SE 8.1.12		☐	☐
SE 8.1.13	Others (specify)	SE 8.1.13		☐	☐

SE 8.2	Domestic lighting and appliances . Number owned			
Sr. No.	Assets		Number Owned (0-do not own)	Hours used per day
SE 8.2.1	Incandescent Bulbs :-	25 Watts	☐	☐☐
		40 watts	☐	☐☐
		60 watts	☐	☐☐
		100 watts	☐	☐☐
		200 watts	☐	☐☐
		0 watt	☐	☐☐
SE 8.2.2	Tubelights:	20 watts	☐	☐☐
		40 watts	☐	☐☐
		60 watts	☐	☐☐
SE 8.2.3	SPV domestic lights		☐	☐
SE 8.2.4	SPV lantern		☐	☐
SE 8.2.5	Biogas lighting system		☐	☐

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SE 8.2.6	Solar water heater		☐	X
SE 8.2.7	Fans:-			
SE 8.2.7.1		Table	☐	X
SE 8.2.7.2		Ceiling	☐	X
SE 8.2.8	Radio		☐	X
SE 8.2.9	Transistor (battery operated)		☐	X
SE 8.2.10	Television		☐	X
SE 8.2.11	Tape recorder/Record player		☐	X
SE 8.2.12	Refrigerator (Capacity____Lits)		☐	X
SE 8.2.13	Petromax Lamp		☐	X
SE 8.2.14	Kerosene lantern		☐	X
SE 8.2.15	Battery tourch		☐	X
SE 8.2.16	Electric Iron		☐	X
SE 8.2.17	Mixer and Grinder		☐	X
SE 8.2.18	Air Conditioner		☐	X
SE 8.2.19	Desert Cooler		☐	X
SE 8.2.20	Others (specify)		☐	X

SE 8.3	Number of vehicles onwed (0-do not own)			
Sr. No.	Assets			
SE 8.3.1	Bicycle	SE 8.3.1		☐
SE 8.3.2	Motorcycle/Scooter/Moped	SE 8.3.2		☐
SE 8.3.3	Truck	SE 8.3.3		☐
SE 8.3.4	Car/Jeep/Van	SE 8.3.4		☐

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SE 8.4	Agricultural Equipments				
Sr. No.	Assets			Number (0-do not own)	Combined Capacity (HP)
SE 8.4.1	Tractors	SE 8.4.1		☐	☐☐
SE 8.4.2	Threshers	SE 8.4.2		☐	☐☐
SE 8.4.3	Power tillers	SE 8.4 3		☐	☐☐
SE 8.4.4	Diesel pumpsets	SE 8.4.4		☐	☐☐☐
SE 8.4.5	Electric pumpsets	SE 8.4.5		☐	☐☐☐
SE 8.4.6	PV pumpsets	SE 8.4.6		☐	☐☐
SE 8.4.7	Wind pumps	SE 8.4.7		☐	☐☐
SE 8.4.8	Bullock carts (Traditional)	SE 8.4.8		☐	X
SE 8.4.9	Bullock carts (Imporved)	SE 8.4.9		☐	X
SE 8.4.10	Biomass gasifier	SE 8.4.10		☐	X
SE 8.4.11	Other (Specify)	SE 8 4.11		☐	☐☐☐
SE 8.1.12	Other (Specify)	SE 8.1.12		☐	☐☐☐
SE 8.5	Other assets				
Sr. No.	Assets			Number(0-do not own)	Combined capacity (HP)
	Pumpset for domestic water supply				
SE 8.5.1	Electric	SE 8.5.1		☐	☐☐
SE 8.5.2	Diesel	SE 8.5.2		☐	☐☐
	Sewing Machine				
SE 8.5.3	Mechanical	SE 8.5.3		☐	X
SE 8.5.4	Electrical	SE 8.5.4		☐	X

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SE 8.6	**Household Industry** (only for households engaged in household industry)			
HHI 1	Do you have household industry 1. Yes, 0.No	HHI 1		
HHI 2	Since how many years are you engaged in this activity? (No. of years)	HHI 2		
HHI 3	Items/products produced or manufactured or processed 1. Yes 0.No			
HHI 3.1	Papads	HHI 3.1		
HHI 3.2	Grinded condiments and spices	HHI 3.2		
HHI 3.3	Embroidery items	HHI 3.3		
HHI 3.4	Silkworm rearing	HHI 3.4		
HHI 3.5	Other 1 (Specify)	HHI 3.5		
HHI 3.6	Other 2 (Specify)	HHI 3.6		
HHI 3.7	Other 3 (Specify)	HHI 3.7		
HHI 4	Number of members engaged in the activity (give Number, 0-None)			
HHI 4.1	Males	HHI 4.1		
HHI 4.2	Females	HHI 4.2		
HHI 4.3	Children	HHI 4.3		
HHI 5	Major fules used in the activity Codes: 1. Electricity 2. Kerosene 3. Firewood 4. Other	HHI 5		
SE 8.7	**Commercial Establishment** (Ask only to those with commerical establishments)			
COMEST1	Does household own a commercial establishment (Shop, etc.)? 1. Yes 0.No	COMEST1		
COMEST2	Type of shop 1. Grocery 2. Cloth 3. Pan Stall 4. Hotel/Tea stall 5. Others (specify)	COMEST2		
COMEST3	Number of family members engaged in the establishment?	COMEST3		

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COMEST4	Establishment is electrified? 1. Yes 0.No	COMEST4		☐
SE 8.8	**Income and Expenditure Details**			
SE 8.8.1	How many members in your household earn income? (No.)			
SE 8.8.1.1	Husband	SE 8.8.1.1		☐
SE 8.8.1.2	Wife	SE 8.8.1.2		☐
SE 8.8.1.3	Sons	SE 8.8.1.3		☐
SE 8.8.1.4	Daughters	SE 8.8.1.4		☐
SE 8.8.1.5	Daughter-in-laws	SE 8.8.1.5		☐
SE 8.8.1.6	Others (Specify)	SE 8.8.1.6		☐
SE 8.8.1.7	Total No. of earners	SE 8.8.1.7		☐☐
SE 8.8.2	Family's total net income (annual) from following sources :			
Sr. No.	Source			Annual Income ('00 Rs.)
SE 8.8.2.1	Agriculture	SE 8.8.2.1		☐☐☐
SE 8.8.2.2	Animal husbandry	SE 8.8.2.2		☐☐☐
SE 8.8.2.3	Selling of Wood	SE 8.8.2.3		☐☐☐
SE 8.8.2.4	Wages/labour (Total)	SE 8.8.2.4		☐☐☐
SE 8.8.2.4.1	Out of which earned by seasonal migrants	SE 8.8.2.4.1		☐☐☐
SE 8.8.2.5	Service (salaried employed)	SE 8.8.2.5		☐☐☐
SE 8.8.2.6	Trading/Selling	SE 8.8.2.6		☐☐☐
SE 8.8.2.7	Remittance	SE 8.8.2.7		☐☐☐
SE 8.8.2.8	Other income (specify)	SE 8.8.2.8		☐☐☐
SE 8.8.2.9	Total annual income	SE 8.8.2.9		☐☐☐☐
SE 8.8.3	Annual expenditure of the family (domestic + agri.+ others)	SE 8.6.3		☐☐☐☐

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PART B : FUEL CHOICE AND ENERGY CONSUMPTION				
EGY 1	**Fuels Used** Over the past one year which of the following fuels have been used by members of your household? (probe by activity i.e. do you use energy for lighting, cooking, heating, cooking aninal feed, HH manufacturing, etc.) 1. Yes, 0. No			
EGY 1.1	Firewood	EGY 1.1		☐
EGY 1.2	Crop residues	EGY 1.2		☐
EGY 1.3	Dung Cakes	EGY 1.3		☐
EGY 1.4	Kerosene	EGY 1.4		☐
EGY 1.5	Charcoal	EGY 1.5		☐
EGY 1.6	Fossil Coal	EGY 1.6		☐
EGY 1.7	LPG	EGY 1.7		☐
EGY 1.8	Biogas	EGY 1.8		☐
EGY 1.9	Diesel	EGY 1.9		☐
EGY 1.10	Petrol	EGY 1.10		☐
EGY 1.11	Electricity	EGY 1.11		☐
EGY 2	If no use of electricity is reported, ask response for non-electrification reasons: Codes : 1. Agree 2. No opinion 3. Disagree 8. Not applicable (HH uses electricity)			
EGY 2.1	Village is not electrified	EGY 2.1		☐
EGY 2.2	Applied for electric connection, however, not yet received	EGY 2.2		☐
EGY 2.3	Amount of security deposit for connection is too high	EGY 2.3		☐
EGY 2.4	Non-ownership of house	EGY 2.4		☐
EGY 2.5	Prefer kerosene for lighting	EGY 2.5		☐

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EGY 2.6	Monthly running cost for electricity use is too high	EGY 2.6		
EGY 2.7	Other	EGY 2.7		
	Fill out energy sections only for fuels used			
	Firewood (Firewood users only, all others - Code 8)			
FW 1	How much firewood do you consume in one day? (No. of units)			
FW 1.1	In Summer (Units)	FW 1.1		
FW 1.2	In Monsoon (Units)	FW 1.2		
FW 1.3	In Winter (Units)	FW 1.3		
FW 1.4	Weight of one unit (Kgs)	FW 1.4		
FW 1.5	Annual consumption (Kgs)*	FW 1.5		
	*** To be filled by supervisor** **Annual consumption (Kgs) = (FW1.1+FW1.2+FW1.3) x 120xFW 1.4**			
FW 2	What percent of firewood do you use in the following activities?			
FW 2.1	Cooking	FW 2.1		
FW 2.2	Water Heating	FW 2.2		
FW 2.3	Cattle Feed Preparation	FW 2.3		
FW 2.4	Warming Up (space heating)	FW 2.4		
FW 2.5	Household manufacturing activities	FW 2.5		
FW 2.6	Commercial establishments	FW 2.6		
FW 2.7	Total	FW 2.7		100%
FW 3	What percent of firewood consumed is :			
FW 3.1	Bought from market	FW 3.1		
FW 3.2	Collected/produced from own trees/fields/ plantation	FW 3.2		
FW 3.3	Collected from roadside/other's field/ community land	FW 3.3		

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FW 3.4	Collected from forest	FW 3.4		
FW 3.5	Total	FW 3.5		100%
FW 4	How do you manage to supplement your need in the situation of poor collection and irregular availability of firewood? 1. Yes, 0.No., 8-Not applicable			
FW 4.1	Never have to supplement	FW 4.1		
FW 4.2	Purchase from market	FW 4.2		
FW 4.3	Borrow from neighbours	FW 4.3		
FW 4.4	Manage with non-cooked items	FW 4.4		
FW 4.5	Others (Specify)	FW 4.5		
FW 5	**Firewood Collectors** (Question FW 5 for firewood collector only, all others-Code 8) If fuelwood is collected, specify :			
FW 5.1	Number of trips per month	FW 5.1		
FW 5.2	Time spent per trip To & Fro (Min.)	FW 5.2		
FW 5.3	One way distance from home (Kms)	FW 5.3		
FW 5.4	Number of persons normally involved:			
FW 5.4.1	Men	FW 5.4.1		
FW 5.4.2	Women	FW 5.4.2		
FW 5.4.3	Children	FW 5.4.3		
FW 5.4.4	Total	FW 5.4.4		
FW 5.5	Most common mode of collection : 1. Head/shoulder load 2. Bullock cart 3. Tractor 4. Bicycle 5. Any other	FW 5.5		

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FW 6	**Fuelwood purchasers** (Question FW 6 is for fuelwood purchaser only, all others- Code 8) If fuelwood is purchased, specify for last purchase:-			
FW 6.1	Total amount (cost) paid (Rs.)	FW 6.1		[ ][ ][ ]
FW 6.2	Number of units purchased	FW 6.2		[ ][ ]
FW 6.3	Average weight of one unit ((Kgs)	FW 6.3		[ ][ ][ ]
FW 6.4	Price per unit (Rs.)	FW 6.4		[ ][ ][ ]
FW 6.5	Total weight of purchased firewood* (Kgs)	FW 6.5		[ ][ ][ ]
FW 6.6	Total days last purchase lasts	FW 6.7		[ ][ ][ ]
	* **Note : To be calculated by supervisor**			
FW 7	**Fuelwood sellers** (Question FW 7 is for fuel sellers only, all others- Code 8) If fuelwood is sold, specify for last sale			
FW 7.1	Number of units sold	FW 7.1		[ ][ ]
FW 7.2	Amount realised from sell (Rs.)	FW 7.2		[ ][ ][ ]
FW 7.3	Average weight of one unit (Kgs)	FW 7.3		[ ][ ][ ]
FW 7.4	Price per unit (Rs.)	FW 7.4		[ ][ ][ ]
FW 7.5	Total weight of firewood sold (Kgs)*	FW 7.5		[ ][ ][ ][ ]
	* **Note : To be calaculated by supervisor**			
Crop Residues (Ask only to those who burn crop residues as fuel, all others- code 8)				
CR 1	Types of crop residues used for burning at home 1. Cotton stalk, 2. Pigeon pea stalk 3. Paddy husk, 4. Mustard stalk 5. Other (specify), 6. Other (specify) 7. Other (specify)	CR 1		[ ] [ ] [ ]
CR 2	How much crop residues do you consume in one day as a fuel? (No. of units)			
CR 2.1	In Summer (Units)	CR 2.1		[ ][ ]
CR 2.2	In Monsoon (Units)	CR 2.2		[ ][ ]
CR 2.3	In Winter (Units)	CR 2.3		[ ][ ]
CR 2.4	Weight of one unit (Kgs)	CR 2.4		[ ][ ][ ]

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CR 2.5	Annual consumption * (Kgs)	CR 2.5		
	* **Note : To be filled by supervisor** **Annual consumption (Kgs) = (CR 2.1 + CR 2.2 + CR 3.3) x 120 x CR 2.4**			
CR 3	What percent of crop residues do you use in the following activities?			
CR 3.1	Cooking	CR 3.1		
CR 3.2	Water Heating	CR 3.2		
CR 3.3	Cattle Feed Preparation	CR 3.3		
CR 3.4	Warming Up (space heating)	CR 3.4		
CR 3.5	Household manufactruing activities	CR 3.5		
CR 3.6	Commercial Establishment	CR 3.6		
CR 3.7	Roofing	CR 3.7		
CR 3.8	Total	CR 3.8		100%
CR 4	What percent of crop residues consumed is :			
CR 4.1	Bought from market	CR 4.1		
CR 4.2	Collected from own fields	CR 4.2		
CR 4.3	Collected from other's fields (free or kind as wages)	CR 4.3		
CR 4.4	Total	CR 4.4		100%
	Crop Residue Collectors (all others - Code 8)			
CR 5	If any crop residue was collected, specify			
CR 5.1	Number of trips per typical month in which crop residues were collected	CR 5.1		
CR 5.2	Number of trips per year	CR 5.2		
CR 5.3	Time spent per trip (Min.)	CR 5.3		
CR 5.4	One way distance from home (kms)	CR 5.4		
CR 6	**Crop Residue Purchasers** (all others - Code 8) If any crop residue was purchased, speicify for last purchase:			
CR 6.1	Total amount (cost) paid (Rs.)	CR 6.1		
CR 6.2	Number of units purchased	CR 6.2		

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CR 6.3	Average weight of one unit (kgs)	CR 6.3		
CR 6.4	Price per unit (Rs.)	CR 6.4		
CR 6.5	Total weight of purchased crop residues* (Kgs)	CR 6.5		
CR 6.6	Total days last purchase lasts	CR 6.6		
	* **Note : To be calculated by supervisor**			
Dung Cakes (Ask only to those who use dung as a fuel, all others- Code 8)				
DC 1	Specify purpose and percent use of cattle dung :			
DC 1.1	Fertilizer	DC 1.1		
DC 1.2	Cooking			
DC 1.2.1	Cakes	DC 1.2.1		
DC 1.2.2	Biogas	DC 1.2.2		
DC 1.3	Other	DC 1.3		
DC 1.4	Total	DC 1 4		100%
DC 2	What is done with ash from cooking? 1. Returns to field. 2. Discarded 3. Other uses	DC 2		
DC 3	How much dungcakes do you consume in one day? (Nos.)			
DC 3.1	In Summer (Nos.)	DC 3 1		
DC 3 2	In Monsoon (Nos)	DC 3.2		
DC 3 3	In Winter (Nos.)	DC 3.3		
DC 3 4	Weight of one dungcake (gms)	DC 3.4		
DC 3.5	Annual consumption* (Kgs)	DC 3.5		
	* **Note : To be filled by supervisor** **Annual consumption (Kgs) = (DC 3.1 + DC 3.2 + DC 3.3) x 120 x DC 3.4 / 1000**			
DC 4	What percent of dungcakes do you use in the following activities?			
DC 4.1	Cooking	DC 4.1		
DC 4.2	Water heating	DC 4.2		

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DC 4.3	Cattle Feed preparation	DC 4.3		
DC 4.4	Warming up (Space heating)	DC 4.4		
DC 4.5	Household manufacturing activities	DC 4.5		
DC 4.6	Commercial Establishment	DC 4.6		
DC 4.7	Total	DC 4.7		100%
DC 5	What percent of dungcakes consumed is :			
DC 5.1	Bought from market	DC 5.1		
DC 5.2	From own cattle shed	DC 5.2		
DC 5.3	Colleted from roadside/grazing lands	DC 5.3		
DC 5.4	Total	DC 5.4		100%
DC 6	**Dung Collectors** (all others Code 8) If any dung was collected, specify:			
DC 6.1	Number of trips per month	DC 6.1		
DC 6.2	Time spent per trip (Min.)	DC 6.2		
DC 6.3	One way distance from home (Kms)	DC 6.4		
DC 6.4	Number of persons normally involved	DC 6.4		
DC 7	**Dungcake Purchasers** (all others code - 8) If any dungcakes were purchased specify for last purchase:			
DC 7.1	Total amount (cost) paid (Rs.)	DC 7.1		
DC 7.2	Number of dungcakes purchased	DC 7.2		
DC 7.3	Average weight of one dungcake (gms)	DC 7.3		
DC 7.4	Total weight of purchased dungcakes* (Kgs)	DC 7.4		
DC 7.5	Total days last purchase lasts	DC 7.5		
	* **Note : To be calculated by supervisor**			
Kerosene (Ask to kerosene users only, all others - Code 8)				
KS 1	How much kerosene do you consume in one month?			
KS 1.1	In Summer (Litres)	KS 1.1		

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KS 1.2	In Monsoon (Litres)	KS 1.2		
KS 1.3	In Winter (Litres)	KS 1.3		
KS 1.4	Annual Consumption (Litres)	KS 1.4		
KS 2	What percent of kerosene do you use in the following activities:			
KS 2.1	Domestic Lighting	KS 2.1		
KS 2.2	Cooking	KS 2.2		
KS 2.3	Water Heating	KS 2.3		
KS 2.4	Cattle Feed Preparation	KS 2.4		
KS 2.5	Warming Up (space heating)	KS 2.5		
KS 2.6	H/H Manufacturing Activities	KS 2.6		
KS 2.7	Commerical Establishment	KS 2.7		
KS 2.8	Total	KS 2.8		100%
KS 3	What is the monthly rationed amount of Kerosene for your family? (Litres)	KS 3		
KS 4	How much kerosene was available from ration quota last month? (Litres)	KS 4		
KS 5	On an average what price did you pay per litre last month? (Paise)			
KS 5.1	From ration shop	KS 5.1		
KS 5.2	From open market	KS 5.2		
KS 6	Distance of the place from where kerosene is obtained (Kms) (Code 0 if purchased in the village)			
KS 6.1	From ration shop	KS 6.1		
KS 6.2	From open market	KS 6.2		

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Charcoal (Ask to charcoal users only, all others- Code 8)				
CC 1	How much charcoal do you consume in one month? (No. of units)			
CC 1.1	In Summer (Units)	CC 1.1		
CC 1.2	In Monsoon (Units)	CC 1.2		
CC 1.3	In Winter (Units)	CC 1.3		
CC 1.4	Weight of one unit (Kgs)	CC 1.4		
CC 1.5	Annual consumption * (kgs.)	CC 1.5		
	* Note : To be filled by supervisor Annual consumption (Kgs) = (CC 1.1 + CC 1.2 + CC 1.3) x 4 x CC 1.4			
CC 2	What per cent of charcoal do you use in the following activities?			
CC 2.1	Cooking	CC 2.1		
CC 2.2	Water Heating	CC 2.2		
CC 2.3	Cattle Feed Preparation	CC 2.3		
CC 2.4	Ironing	CC 2.4		
CC 2.5	Warming Up (Space heating)	CC 2.5		
CC 2.6	H/H Manufacturing Activities	CC 2.6		
CC 2.7	Total	CC 2.7		100%
CC 3	On an average what price did you pay per Kg. of charcoal last time? (Paise)	CC 3		
Fossil Coal (Ask to coal users only, all others code - 8)				
FC 1	How much fossil coal do you consume in one month? (No. of units)			
FC 1.1	In Summer (Units)	FC 1.1		
FC 1.2	In Monsoon (Units)	FC 1.2		
FC 1.3	In Winter (Units)	FC 1.3		
FC 1.4	Weight of one unit (Kgs)	FC 1.4		
FC 1.5	Annual consumption * (Kgs)	FC 1.5		
	* Note : To be filled by supervisor [illegible]			

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FC 2	What percent of fossil coal do you use in the following activities?			
FC 2.1	Cooking	FC 2.1		
FC 2.2	Water Heating	FC 2.2		
FC 2.3	Cattle Feed Preparation	FC 2.3		
FC 2.4	Warming Up (space heating)	FC 2.4		
FC 2.5	H/H Manufacturing Activities	FC 2.5		
FC 2.6	Total	FC 2.6		100%
FC 3	On an average what price did you pay per kg. of fossil coal last time? (Paise)	FC 3		
LPG (Ask to LPG users only, All others- code 8)				
LPG 1	How many LPG cylinders do you consume in one year?	LPG 1		
LPG 2	How many days does a cylinder normally last?	LPG 2		
LPG 3	What is the size of your LPG cylinder in Kgs? (last box is for decimal)	LPG 3		
LPG 4	What price did you pay for cylinder last time? (Rs.)	LPG 4		
LPG 5	Normally how long do you have to wait to get the cylinder? (days)	LPG 5		
LPG 6	Distance of the place from where LPG cylinder is obtained (Kms)	LPG 6		
LPG 7	What percent of LPG do you use in the following activities? (code 0 for none)			
LPG 7.1	Cooking	LPG 7.1		
LPG 7.2	Wate Heating	LPG 7.2		
LPG 7.3	Cattle Feed Preparation	LPG 7.3		
LPG 7.4	Warming Up (space heating)	LPG 7.4		
LPG 7.5	H/H Manufacturing Activities	LPG 7.5		
LPG 7.6	Commerical establishment	LPG 7.6		
LPG 7.7	Total	LPG 7.6		100%
LPG 8	Since how many years are you using LPG?	LPG 8		

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Biogas (Ask to biogas users only, all others - Code 8)				
BG 1	Type of biogas plant 1. Individual 2. Community	BG 1		□
BG 2	Capacity of the individual biogas plant (Cum.)	BG 2		□
BG 3	Type of biogas stove 1. Single burner, 2. Double burner	BG 3		□
BG 3.1	Diameter of burner(s) in mm.	BG 3.1		□□□ □□□
BG 4	Number of hours/day used:			
BG 4.1	In Summer (hrs/day)	BG 4.1		□
BG 4.2	In Monsoon (hrs/day)	BG 4.2		□
BG 4.3	In Winter (hrs/day)	BG 4.3		□
BG 4.4	Annual consumption (hrs)	BG 4.4		□□□
BG 5	What percent of biogas do you use in the following activities?			
BG 5.1	Cooking	BG 5.1		□□
BG 5.2	Water heating	BG 5.2		□□
BG 5 3	Cattle feed preparation	BG 5.3		□□
BG 5 4	Warming up	BG 5.4		□□
Bg 5.5	Domestic lighting	BG 5.5		□□
BG 5.6	Household manufacturing activities	BG 5.6		□□
BG 5.7	Total	BG 5.7		100%
BG 6	Quantity of raw dung used per day for biogas plant (Kgs)	BG 6		□□□
BG 7	How many months during the year does the biogas plant operate?	BG 7		□□
BG 8	Fequency of break down of the biogas plant during last one year (No. of times)	BG 8		□□

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BG 9	Frequency of contacts/visits by the biogas extension agents during last one year (No. of times)	BG 9		
BG 10	If biogas is obtained from the community biogas plant, monthly charges paid (Rs.)	BG 10		
Electricity (Ask to electricity users only, all others- Code 8)				
ELEC 1	**Domestic Lighting including use of appliances**			
ELEC 1.1	Is domestic electricity metered? 1. Yes 0. No	ELEC 1.1		
ELEC 1.2	If yes, details of the last domestic electricity bill received			
ELEC 1.2.1	Electicity (SEB) meter No	ELEC 1 2.1		
ELEC 1.2.2	Date of bill	ELEC 1.2.2		
ELEC 1.2.3	Period covered (days)	ELEC 1.2.3		
ELEC 1.2.4	No. of units consumed (Kwhr)	ELEC 1.2.4		
ELEC 1.2.5	Amount of bill (Rs)	ELEC 1.2.5		
ELEC 1.2.6	Average Price (Rs./kwhr)	ELEC 1.2.6		
ELEC 1.3	Domestic electricity supply is : 1. Most irregular 2. Irregular 3. Normal	ELEC 1.3		
ELEC 1.4	Over the past one month how many times has the domestic current failed?	ELEC 1.4		
ELEC 1.5	Please indicate whether the following problems occured during last one month in domestic electricity supply Codes : 1. Daily, 2. Weekly, 3 Rarely, 4. Never			
ELEC 1.5.1	Voltage drops, dimming of lights	ELEC 1 5.1		
ELEC 1.5.2	Unscheduled power cuts	ELEC 1.5.2		
ELEC 2	**Irrigation**			
ELEC 2.1	On an average how many hours per day the electric pumpsets are used in different seasons (hrs/day)			
ELEC 2.2.1	Summer season	ELEC 2.1.1		

ID Household

ELEC 2.1.2	Monsoon season	ELEC 2.1.2		
ELEC 2.1.3	Winter season	ELEC 2.1.3		
ELEC 2.2	Is agriculture electricity use metered? Yes-1, No-0	ELEC 2.2		
ELEC 2.3	If yes, details of the agriculture electricity bill recieved :			
ELEC 2.3.1	Electricity (SEB) meter No.	ELEC 2.3.1		
ELEC 2.3.2	Date of Bill	ELEC 2.3 2		
ELEC 2.3.3	Period covered (days)	ELEC 2.3.3		
ELEC 2.3.4	No. of units consumed (Kwhr)	ELEC 2.3.4		
ELEC 2.3 5	Amount of bill (Rs)	ELEC 2.3.5		
ELEC 2.3 6	Average Price (Rs./Kwhr)	ELEC 2.3 6		
ELEC 2.4	In case electricity is not metered and charged on pumpset capacity, specify annual charges .-			
ELEC 2.4 1	For 2 5 H P Pump (Rs.)	ELEC 2 4 1		
ELEC 2.4.2	For 5 H P Pump (Rs.)	ELEC 2.4.2		
ELEC 2.4 3	For 7 5 H P Pump (Rs.)	ELEC 2 4 3		
ELEC 2.4 4	For 10 H P Pump (Rs)	ELEC 2 4 4		
ELEC 2.5	Agriculture electricity supply is: 1 Most irregular 2. Irregular 3. Normal	ELEC 2.5		
ELEC 2.6	Over the past one month how many times has the current failed for agriculture supply?	ELEC 2 6		
ELEC 2.7	Please indicate whether the following problems occured during the last one month in agriculture electricity supply Code : 1. Daily 2. Weekly 3. Rarely, 4 Never			
ELEC 2.7 1	Voltage drops	ELEC 2.7 1		
ELEC 2 7 2	Unscheduled powercuts	ELEC 2.7.2		
ELEC 3	**Commercial Establishment in the house**			
ELEC 3.1	Do you have separate electricity meter for your establishment? 1. Yes 0 No	ELEC 3.1		

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ELEC 3.2	If yes, details of the last commercial establishment electricity bill received			
ELEC 3.2.1	Electricity (SEB) meter No.	ELEC 3.2.1		
ELEC 3.2.2	Date of Bill	ELEC 3.2.2		
ELEC 3.2.3	Period covered (days)	ELEC 3.2.3		
ELEC 3.2.4	No of units consumed (Kwhr)	ELEC 3.2.4		
ELEC 3.2.5	Amount of bill (Rs.)	ELEC 3.2.5		
ELEC 3.2.6	Average Price (Rs./Kwhr)	ELEC 3.2.6		
	Diesel (Ask for diesel users only, all others- code 8)			
DL 1	How much diesel do you consume in one month.			
DL 1.1	In Summer (litres)	DL 1.1		
DL 1.2	In Monsoon (Litres)	DL 1.2		
DL 1.3	In Winter (Litres)	DL 1.3		
DL 1 4	Annual consumption (litres)*	DL 1 4		
DL 1.5	Annual expenditure (Rs)**	DL 1 5		
	To be filled by supervisor *** Annual consumption (Litres) = (DL 1.1 + DL 1.2 + DL 1.3) x 4** **** Annual expenditure (Rs.) = $\frac{\text{DL 1.4 x DL 3}}{100}$**			
DL 2	What percent of diesel do you use in the following activities?			
DL 2.1	Irrigation	DL 2.1		
DL 2.2	Other Agricultural Operations	DL 2 2		
DL 2.3	Transport	DL 2.3		
DL 2.4	Any other (specify)	DL 2.4		
DL 2.5	Total	DL 2.5		100%
DL 3	Price of diesel (Paise/Lit)	DL 3		
DL 4	Distance of the place from where diesel is obtained (kms) (Code 0 if purchased in the village)	DL 4		

ID Household □□□□□□□□

DL 5	Annual diesel expenditure on irrigation* (Rs.)	DL 5		□□□□
	*** Note : To be filled by supervisor** **Annual diesel expenditure on Irrigation (Rs.) = $\frac{\text{DL 1.5 x DL 2.1}}{100}$**			
	Petrol(Ask to petrol users only, all others- Code 8)			
PET 1	How much petrol do you consume?			
PET 1.1	Monthly conmsumption (litres)	PET 1.1		□□
PET 1.2	Annual Consumption (Litres)	PET 1.2		□□□
PET 2	Price of petrol (Paise/Lit)	PET 2		□□□□
PET 3	Distance of the place from where petrol is obtained (Kms)	PET 3		□□

ID Household

Part C : Employment Related Questions				
Animal Husbandry (Ask those owning livestock, all others-8)				
AH 1	Livestock holding details:			
Sr. No.	Particulars	Number		
		Adult (>3 yrs)	Young (<3 yrs)	Total
AH 1.1	Buffaloes			
AH 1.2	Cows			
AH 1.3	Bulls			
AH 1.4	Bullocks			
AH 1.5	Goats	X	X	
AH 1.6	Sheep	X	X	
AH 1.7	Camels	X	X	
AH 2	Average per day dung available at home (all cattle together) (Kgs)	AH 2		
Agriculture (Ask to farmers only, all others - code 8)				
AGRI 1	Land cultivated (Last Year) :			
AGRI 1.1	Rainfed (Ha)	AGRI 1.1		
AGRI 1.2	Irrigated (Ha.)	AGRI 1.2		
AGRI 1.3	Land not sown (Ha.)	AGRI 1.3		
AGRI 1.4	Land not suitable for cultivation (Ha)	AGRI 1.4		
AGRI 1.5	Number of fragements of land	AGRI 1.5		
AGRI 2	Area irrigated by source			
AGRI 2.1	Canal (Ha.)	AGRI 2.1		
AGRI 2.2	Dugwell/Dug-cum-borewell :			
AGRI 2.2.[illegible]	With [illegible] pumpse[illegible] (Ha.)	AGRI 2.2.[illegible]		

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AGRI 2.2.2	With diesel pumpsets (Ha.)	AGRI 2.2.2			
AGRI 2.2.3	Animal driven (Ha.)	AGRI 2.2.3			
AGRI 2.3	Tubewells (Ha.)	AGRI 2.3			
AGRI 2.4	Lift (Ha.)	AGRI 2.4			
AGRI 2.5	Others (Specify)	AGRI 2.5			

AGRI 3	Crop Area and Production				
Season	Crops*	Area (Ha)**	Production (Qts)	Farmgate Price (Rs/Qt)	Value of Produce (Rs)***
Kharif (Monsoon)	1				
	2				
	3				
	4				
Rabi (Winter)	1				
	2				
	3				
Hot weather (summer)	1				
	2				
	3				
Two-seasonal	1				
	2				
Perennial	1				
	2				
	3				

Note : * Crop codes not to be filled
** Area (Ha.) : Last box is for decimal
*** Value of produce to be calculated by supervisor

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AGRI 4	**Rectification of pumping system** (only for farming households using pumpsets for irrigation, all others - code 8)			
AGRI 4 1	Does your pump yield low discharge? (1. No, 2. Sometimes, 3. Frequently)	AGRI 4.1		☐
AGRI 4.2	If yes, what are the reasons for the low discharge? : 1 Yes, 0 No			
AGRI 4 2.1	Pump Deficiency	AGRI 4.2.1		☐
AGRI 4.2 2	Inadequate groundwater yield	AGRI 4 2.2		☐
AGRI 4.2.3	Low voltage of electricity supply	AGRI 4.2.3		☐
AGRI 4.2 4	No. of pumpsets operating in the vicinity	AGRI 4 2.4		☐
AGRI 4.2.5	Others (Specify)	AGRI 4.2.5		☐
AGRI 4.3	Give the name and location of nearest agency available for servicing and repair of the pump Name :______________ Distance (Kms):________	AGRI 4.3		☐☐
AGRI 4 4	Is your pump rectified? 1. Yes, 0. No 2. Never heard about the programme	AGRI 4 4		☐
AGRI 4.5	If yes, details of rectification carried out (If no, go to TP.1 and Code 8 below)			
AGRI 4.5.1	How long ago was the pump rectified? (Months)	AGRI 4.5.1		☐☐
AGRI 4.5.2	Who selected your pump for rectification? 1. Rural electrification Corpn. Ltd., 2. State Electricity Board 3. State Energy Nodal Agency 4. Self 5. Other (Specify)	AGRI 4.5.2		☐
AGRI 4.5.3	Describe the nature of rectification.- (1. Yes 0. No)			
AGRI 4.5.3.1	Change of pump	AGRI 4.5.3.1		☐
AGRI 4.5 3.2	Change of foot valve	AGRI 4.5.3.2		☐

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AGRI 4.5.3.3	Change of suction pipe .	AGRI 4.5.3.3		
AGRI 4.5.3.4	Change of delivery pipe	AGRI 4.5.3.4		
AGRI 4.5.3.5	Any other (Specify)	AGRI 4.5.3.5		
AGRI 4.5.4	Changes observed in pump system due to rectification (1. Increased, 2. Decreased, 3. No change)			
AGRI 4.5.4.1	Water discharge	AGRI 4.5.4.1		
AGRI 4.5.4.2	Diesel/electricity consumption	AGRI 4 5 4.2		
Tree Planting Details (only for households undertaken tree planting, all others- Code 8)				
TP 1	Do you have a tree plantations? (including orchards) 1. Yes, 0 No	TP 1		
TP 2	If yes, area of plantation (Ha.)	TP 2		
TP 3	Types of speices grown : 1. Yes, 0 No			
TP 3 1	Timber Species	TP 3.1		
TP 3 2	Fuelwood species	TP 3 2		
TP 3 3	Fooder Species	TP 3.3		
TP 3 4	Fruit trees	TP 3 4		
TP 3 5	Multi purpose species	TP 3 5		
TP 4	Number of trees planted last year:			
TP 4.1	Planted on plantation (No)	TP 4.1		
TP 4 2	Planted around farm (No.)	TP 4.2		
TP 5	Out of 10 trees you plant, generally how many survive after 2 years (No)	TP 5		
TP 6	Number of trees around the farm (on farm bunds)	TP 6		
TP 7	Number of permanent trees in the field	TP 7		
TP 8	Number of trees owned by you around the house	TP 8		
TP 9	Do you sell the produce from tree planting? 1. yes, 0 No	TP 9		

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TP 10	Problems experienced in tree plantation 1. Yes, 0. No			
TP 10 1	Lack of adequate land	TP 10.1		☐
TP 10.2	Other labour priority	TP 10.2		☐
TP 10.3	Shortage of seedlings/seeds	TP 10.3		☐
TP 10 4	Insufficient water for irrigation	TP 10.4		☐
TP 10.5	Lack of knowledge about growing trees	TP 10.5		☐
TP 10 6	Lack of extension services	TP 10.6		☐
TP 10 7	Low product value	TP 10 7		☐
TP 10.8	Other (Specify)	TP 10.8		☐
TP 10 9	Other (Specify)	TP 10 9		☐
TP 11	Are you planning to expand your tree planting activity in next 2 years			
TP 11 1	On plantation/field	TP 11.1		☐
TP 11.2	Around farm	TP 11 2		☐
TP 11 3	Around house	TP 11.3		☐

ID Household ☐☐☐☐☐☐☐☐

PART D : Opinions and Attitudes (Ask to all Households)

Opinions

OP 1	For lighting which of the following sources of energy would you prefer, if available and cost is not a constraint? 1. Kerosene, 2. Electricity 3. Other (specify)	OP 1		☐

OP 2 — Please rank the following fules which you would say is the best for cooking in terms of:

Fuel choice rank	Cost	Convenience	Availability
First	☐	☐	☐
Second	☐	☐	☐

Fuel Codes: 1. Kerosene 2. Electricity 3 Firewood 4. Dungcakes 5. Agri. residues 6. Charcoal 7. Coal 8. LPG 9. Biogas

OP 3 — Please rank the following fuels which you would say is the best for irrigation in terms of.

Fuel choice rank	Cost	Convenience	Availability
First	☐	☐	☐
Second	☐	☐	☐

Fuel codes : 1. Electricity 2. Diesel 3. Solar

OP 4	Have you switched your main cooking fuels over the last 5 years? 1.Yes 0.No	OP 4		☐

OP 4.1 — If yes, give details

From Fuel	To Fuel	Main Reasons
☐	☐	☐☐☐
☐	☐	☐☐☐

Codes for fuels : 1. Firewood 2. Crop residues 3. Dungcake 4. Kerosene 5. Charcoal 6. Fossil Coal 7. LPG 8. Biogas 9. Electricity

Codes for reasons :

1. Moved to another place
2. Became more difficult to get previous fuel
3. Current fuel is more affordable
4. Current fuel is convenient
5. Price of previous fuel became too high
6. Time saving by current fuel
7. New equipment was bought that requires use of current fuel
8. Current fuel is less hazardous
9. Other (Specify)

ID Household ☐☐☐☐☐☐☐☐

PART D : Opinions and Attitudes (Ask to all Households)

Opinions

OP 1	For lighting which of the following sources of energy would you prefer, if available and cost is not a constraint? 1. Kerosene, 2. Electricity 3. Other (specify)	OP 1		☐

OP 2 — Please rank the following fules which you would say is the best for cooking in terms of·

Fuel choice rank	Cost	Convenience	Availability
First	☐	☐	☐
Second	☐	☐	☐

Fuel Codes: 1. Kerosene 2. Electricity 3 Firewood 4. Dungcakes 5. Agri. residues 6. Charcoal 7. Coal 8. LPG 9. Biogas

OP 3 — Please rank the following fuels which you would say is the best for irrigation in terms of.

Fuel choice rank	Cost	Convenience	Availability
First	☐	☐	☐
Second	☐	☐	☐

Fuel codes : 1. Electricity 2. Diesel 3. Solar

OP 4	Have you switched your main cooking fuels over the last 5 years? 1.Yes 0.No	OP 4		☐
OP 4.1	If yes, give details			
	From Fuel	To Fuel		Main Reasons
	☐	☐		☐☐☐
	☐	☐		☐☐☐

Codes for fuels : 1. Firewood 2. Crop residues 3. Dungcake 4. Kerosene 5. Charcoal 6. Fossil Coal 7. LPG 8. Biogas 9. Electricity

Codes for reasons :

1. Moved to another place
2. Became more difficult to get previous fuel
3. Current fuel is more affordable
4. Current fuel is convenient
5. Price of previous fuel became too high
6. Time saving by current fuel
7. New equipment was bought that requires use of current fuel
8. Current fuel is less hazardous
9. Other (Specify)

ID Household ☐☐☐☐☐☐☐☐

OP 5	Will you like to switch over from your current fuels to new fuels in the near future? 1. Yes, 0.No 2. Cant say	OP 5		☐
OP 5.1	If yes, give details			
	From Fuel	To Fuel		Main Reasons
	☐	☐		☐☐☐
	☐	☐		☐☐☐

Codes for fuels :

1. Firewood, 2. Crop residues, 3. Dungcakes 4. Kerosene
5. Charcoal 6. Fossil coal 7. LPG 8. Biogas 9. Electricity

Codes for reasons:
1. Scarcity of current fuel 2. High cost of current fuel 3. Current fuel is hazardous,
4. Current fuel is more time consuming 5. Current fuel is inconvenient to use
6. Other (specify) 7. Other (specify)

OP 6	What do you think about following fuels? 1. Taxed 2. Subsidised 3. Neither taxed nor subsidised 4. Don't know			
OP 6.1	Electricity for Domestic Use	OP 6.1		☐
OP 6.2	Electricity for Agriculture	OP 6.2		☐
OP 6.3	Kerosene	OP 6.3		☐
OP 7	What do you say about the following energy issues? Codes : 1. Strongly agree 2. Agree 3. No Opinion 4. Disagree 5.Strongly disagree			
OP 7.1	Fuelwood is in great shortage	OP 7 1		☐
OP 7.2	There are few trees today in the village	OP 7.2		☐
OP 7.3	In the future fuelwood will be even more scarce than today	OP 7.3		☐
OP 7.4	More trees should be planted in future	OP 7.4		☐
OP 7.5	Farmers should plant more trees	OP 7.5		☐
OP 7.6	Burning dung does not take ferlizer away from agricultural fields	OP 7.6		☐

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OP 7.7	Using electricity is too expensive for lighting	OP 7.7		☐
OP 7.8	Using electricity is not reliable for lighting	OP 7.8		☐
OP 7.9	Using electricity is too expensive for irrigation	OP 7.9		☐
OP 7.10	Using electricity is not reliable for irrigation	OP 7.10		☐
OP 7.11	I would be willing to pay more for electricity if there were few power cuts and dimming	OP 7.11		☐
OP 7.12	It is better to have agricultural pumpset meters alognwith very reliable supply of electricity rather than fixed rates (no meter) at current level of supply	OP 7.12		☐
OP 7.13	Electricity is more expensive than kerosene for lighting	OP 7.13		☐
General Life Style				
GLS 1	How often members of your household read newspapers? 1. Daily 2. Weekly 3. Monthly 4. Never/rarely	GLS 1		☐
GLS 2	How often members of your household listen to the radio? 1. Daily 2. Weekly 3. Monthly 4. Never/rarely	GLS 2		☐
GLS 3	How often members of your households watch TV? 1. Daily 2. Weekly 3. Monthly 4. Never/rarely	GLS 3		☐
	Codes for GLS 4,5 & 6 1 Better, 2. Same, 3. Worse, 4. Can't Say			
GLS 4	Compared to your father's time, do you think that the life you lead is:	GLS 4		☐
GLS 5	Compared to your neighbourhood do you think that the life you lead is:	GLS 5		☐
GLS 6	Compared to today, do you think that the life you are likely to lead five years from now will be :	GLS 6		☐
GLS 7	How often do you go to a cinema? ____________times per month	GLS 7		☐☐

Household

Part E **Marketing of Renewables Energy Devices**

Awareness and willingness to purchase Individual Renewable Energy Devices

RE 1 What is your level of knowledge and interest in the following technologies? 1 Yes, 0. No, 2. Don't Know

Sr. No	Technology	Already owns it	Heard about it	Available in market	Interested in purchasing without credit	Interested in purchasing without credit	Not interested	If owns/ purchased amount paid* (Rs.)
RE 1.1	Individual biogas plant							
RE 1 2	Improved chulha							
RE 1.3	Solar cooker							
RE 1.4	SPV domestic light							
RE 1.5	SPV lantern							
RE 1.6	Biogas lighting system							
RE 1 7	Solar water heater							
RE 1 8	Solar pump							
RE 1.9	Wind Pump							
RE 1.10	Improved bullock cart							
RE 1 11	Pressure cooker							

* Notes : Code 222 ...., if device owned, but does not know price
Code 000 ...., if 100% subsidised
Code 888 ...., if not applicable

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RE 2	**Opinion on Renewable Energy Devices** Codes : 1. Strongly agree 2. Agree 3. No opinion 4. Diagree 5. Strongly disagree			
RE 2.1	**Biogas (Plant)**			
RE 2.1.1	Biogas is very clean and efficient technology for cooking	RE 2.1.1		☐
RE 2.1.2	Biogas consumes less energy compared to traditional chulha	RE 2.1.2		☐
RE 2.1.3	Biogas plant is easy to operate and maintain	RE 2.1.3		☐
RE 2.1.4	Using biogas is too expensive for my cooking needs	RE 2.1.4		☐
RE 2.1.5	Biogas plant occupies (too much) large space	RE 2.1.5		☐
RE 2.1.6	Using biogas is very dangerous	RE 2.1.6		☐
RE 2.1.7	Use of biogas increases indoor pollution	RE 2.1.7		☐
RE 2.2	**Improved Chulha**			
RE 2.2.1	Improved chulha is clean and efficient technology for cooking	RE 2.2.1		☐
RE 2.2.2	Improved chulha consumes less energy compared to traditional chulha	RE 2.2.2		☐
RE 2.2.3	All cooking activities cannot be done on improved chulha	RE 2.2.3		☐
Re 2.2.4	Improved chulha creates less smoke in the kitchen	Re 2.2.4		☐
RE 2.2.5	Use of improved chulha creates less respiratory diseases for women	RE 2.2.5		☐
RE 2.2.6	Construction/repairing of an improved chulha is a waste of my money	RE 2.2.6		☐
RE 2.3	**Solar Cooker**			
RE 2.3.1	Solar cooker is clean and efficient technology for cooking	RE 2.3.1		☐

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RE 2.3.2	Using solar cooker is too expensive for my cooking needs	RE 2.3.2		☐
RE 2.3.3	Solar cooker occupies large space	RE 2.3.3		☐
RE 2.3.4	Design of solar cooker is inconvenient (large size and weight)	RE 2.3.4		☐
RE 2.3.5	Timings of cooking on solar cooker are not convenient	RE 2.3.5		☐
RE 2.3.6	All cooking activities cannot be done on solar cooker	RE 2.3.6		☐
RE 2.3.7	I will be using solar cooker for cooking meals in future	RE 2.3.7		☐
RE 2.4	**PV Domestic/Street Lights**			
RE 2.4.1	PV lighting is clean and efficient technology for lighting	RE 2.4.1		☐
RE 2.4.2	Using PV lights is too expensive	RE 2.4.2		☐
RE 2.4.3	PV lights are easy to operate and maintain	RE 2.4.3		☐

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Part F. Special Supplementary Section on Cooking				
Management of cooking fuels by women (Ask only to those who cook)				
SS 1	**Female respondent's Name**	SS 1		
SS 2	Relation with head of the household: 1. Wife 2. Mother 3. Daughter 4. Daughter-in-law 5. Sister 6. Other	SS 2		☐
SS 3	Age (yrs)	SS 3		☐☐
SS 4	Fuelwood collection (for those who collect fuelwood, all others-8):-			
SS 4.1	Do you or other female member in your family go out exclusively for collecting firewood or along with other activities or do you do both? 1. Go exclusively for fuel collection 2. Combine with other activities 3. Both (i.e. sometimes go only for fuel collection and sometimes combine with other activities)	SS 4.1		☐
SS 4.2	If fuel collection is combined with other activities, normally what are those activities? 1. Farm 2. Water fetching 3. Grazing of animals 4. Other activity (specify) 5. Not combined with other activities (exclusively fuelwood collection)	SS 4.2		☐☐
SS 5	Average time allocation by adult female members on various activities yesterday Considering 24 hours in a day, give proportion of time spent on various activities by female members yesterday (time in hrs and Min.)			
SS 5.1	Food Processing (Grinding, flour making, pounding)	SS 5.1		☐☐☐
SS 5.2	Fuel collection	SS 5.2		☐☐☐

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SS 5.3	Cooking and servicing (includes carrying food to fields)	SS 5.3		
SS 5.4	Cleaning dishes/utensils, household cleaning, washing clothes	SS 5.4		
SS 5.5	Water fetching	SS 5.5		
SS 5.6	Taking meals	SS 5.6		
SS 5.7	Self bathing	SS 5.7		
SS 5.8	Caring of children (bathing, dressing, feeding, studies)	SS 5.8		
SS 5.9	Marketing/shopping	SS 5.9		
SS 5.10	Income production activities (agriculture, animal husbandry, etc.)	SS 5.10		
SS 5.11	Rest (day nap, night sleep)	SS 5.11		
SS 5.12	Leisure time (listening to radio, social activities)	SS 5.12		
SS 5.13	Watching TV	SS 5.13		
SS 5.14	Reading (studying/homework)	SS 5.14		
SS 5.15	Others (Specify)	SS 5.15		

SS 6	Do you know the following renewable energy devices? Knowledge code : 0. Never heard of it 1. Know through domonstration/extension programme 2. Know through media, 3. Know somebody who uses it, 4. Use if myself			
SS 6.1	Smokeless chulha	SS 6.1		
SS 6.2	Biogas plant	SS 6.2		
SS 6.3	Solar cooker	SS 6.3		
SS 6.4	Pressure cooker	SS 6.4		

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SS 7	Attitude towards renewable devices, in my opinion Attitude code : 1 - A useful device for cooking 2 - Not useful for cooking 3 - No opinion			
SS 7.1	Smokeless chulha is :	SS 7.1		☐
SS 7.2	Individual biogas plant is :	SS 7.2		☐
SS 7.3	Solar cooker is :	SS 7.3		☐
SS 7.4	Pressure cooker is :	SS 7.4		☐

CENSUS SCHEDULE

INDIA RURAL ENERGY STUDY

Project Code

W	B
C	S

State :____________________ [ ]

District :____________________ [ ]

Block :____________________ [ ]

Village :____________________ [ ]

Household No :____________________ [ ][ ][ ][ ]

Name of head of household . ____________________

ID Household .____________________ [ ][ ][ ][ ][ ][ ][ ][ ]

Study Sponsored by

The World Bank, Washington, D.C

Name of the Investigator : ____________________

Date : ____________________

Verified by : ____________________

OPERATIONS RESEARCH GROUP

Baroda - 1995

ID Household ☐☐☐☐☐☐☐☐

RURAL ENERGY STUDY
(CENSUS SCHEDULE)

Q 1.0	**Identification**			
Q 1.1	State :________________	Q 1.1		☐
Q 1.2	District :________________	Q 1.2		☐
Q 1.3	Block/Tehsil/Taluka :__________	Q 1.3		☐
Q 1.4	Village :______________	Q 1.4		☐
Q 1.5	Mohalla/House No. :__________	Q 1.5		☐☐☐☐
Q 1.6	Name of head of household :__________	Q 1.6		
Q 2.0	**Type of House** **1. Kutcha 2. Pucca 3. Mixed**	**Q 2.0**		☐
Q 3.0	Total members in the family			
Q 3.1	Male (+ 16)	Q 3.1		☐
Q 3.2	Female (+ 16)	Q 3.2		☐
Q 3.3	Children (-16)	Q 3.3		☐
Q 3.4	Total	Q 3.4		☐☐
Q 4.0	**Household's Caste :** **1. S/C 2. S/T 3. Other**	Q 4.0		☐
Q 5.0	**Main source of income in the family** I. Farming Land cultivated (Ha.) __________ (1) Large (> 3Ha.)__________ (2) Medium (2-3 Ha.) __________ (3) Small (1-2 Ha.) __________ (4) Marginal (<1 Ha.) __________	**Q 5.0**		☐
	II. (5) Agri. Labour __________ III. (6) Non-Agri. Labour Specify ________			

ID Household □□□□□□□□

	IV. (7) Artisans (Potter, Carpenter, Smithy. etc. Specify)________ V. (8) Others :________ i) Service (Govt. & Pvt. Job) ii) Business (shops, etc. specify) iii)Others (specify)			

Q 6.0 Number of animals owned

Sr. No.	Particulars	Cows	Bulls	Bullocks	Buffaloes		Sheep/goats
					He	She	
Q 6.1	Adult (>3 yrs)	□□	□	□	□	□	□□□
Q 6.2	Young (<3 yrs)	□□	□	□	□	□	□□□
Q 6.3	Total	□□	□	□	□	□	□□□

Q 7.0	**Major Cooking Fuels Used** 1. Firewood/Branches 2. Dungcakes 3. Agri. Wastes 4. Kerosene 5. Biogas 6. LPG 7. Coal 8. Other (specify)	Q 7.0		□□□
Q. 7.1	Total consumption of kerosene per month ________ litres	Q 7.1		□□

ID Household □□□□□□□□

Q 8.0	New and Renewable energy devices				
Sr. No.	Device	No.	Working	Not Working	Demolished
Q 8.1	Bio-gas plant	□	□	□	□
Q 8.2	Improved chulha	□	□	□	□
Q 8.3	Solar cooker	□	□	□	□
Q 8.4	Solar heater	□	□	□	□
Q 8.5	Wind pump	□	□	□	□
Q 8.6	PV pump	□	□	□	□
Q 8.7	PV Domestic light	□	□	□	□
Q 8.8	Other (specify)	□	□	□	□
Q 9.0	**Domestic electricity connection** 1. Yes 0. No		**Q 9.0**		□

10. Tree plantation details, if any :

Sr. No.	Plantation Type	If done	
		1 Yes 0 No	Status*
Q. 10.1	Block/farm	□	□
Q 10.2	Bund/border	□	□
Q 10.3	Agro-forestry	□	□

*Status
1. Harvested
2. Not harvested
3. Partially harvested

VILLAGE SCHEDULE

INDIA RURAL ENERGY STUDY

Project Code		W B / V S
State	:________________	☐
District	:________________	☐
Block	:________________	☐
Village	:________________	☐
ID Village	:________________	☐☐☐☐

Study Sponsored by

The World Bank, Washington, D.C

Name of the Investigator :________________

Date :________________

Verified by :________________

OPERATIONS RESEARCH GROUP
Baroda - 1995

ID Village ☐☐☐☐

INDIA RURAL ENERGY STUDY
(VILLAGE SCHEDULE)

Q 1.0	**Identification**			
Q 1.1	State :____________	Q 1.1		☐
Q 1.2	District :____________	Q 1.2		☐
Q 1.3	Tehsil/Taluka/Block ____________	Q 1.3		☐
Q 1.4	V.L.W Circle ____________	Q 1.4		
Q 1.5	Village :-			
Q 1.5.1	Name	Q 1.5.1		
Q 1.5.2	ID Code	Q 1.5.2		☐
Q 1.5.3	1991 Census code	Q 1.5.3		☐☐☐
Q 2.0	**Electrification Details (Elec.)**			
Elec.1	Whether Grid electrified? 1. Yes, 0. No	Elec.1		☐
Elec.1.1	If yes,			
Elec. 1.1.1	Year of electrification	Elec. 1.1.1		☐☐
Elec. 1.1.2	Number of electrical connections:			
Elec. 1.1.2.1	Domestic :____________	Elec. 1.1.2.1		☐☐☐
Elec. 1.1.2.2	Agricultural :____________	Elec. 1.1.2.2		☐☐☐
Elec. 1.1.2.3	Industrial :____________	Elec. 1.1.2.3		☐☐
Elec. 1.1.2.4	Commerical :____________	Elec. 1.1.2.4		☐☐
Elec. 1.1.2.5	Institutional :____________	Elec. 1.1.2.5		☐☐
Elec. 1.1.2.6	Streetlights :____________	Elec. 1.1.2.6		☐☐
Elec. 1.1.3	Connected load of the village (K.W)	Elec. 1.1.3		☐☐

ID Village

Elec.1.2	If village has no electricity, distance from the nearest grid line (Kms.)	Elec.1.2		
Elec.2	Whether non-grid electrified? 1 Yes, 0.No	Elec.2		
Elec.2.1	If yes, give number of systems/sets/units, etc:-			
Elec. 2.1.1	Household PV System	Elec.2.1.1		
Elec. 2.1.2	Small (diesel) generating sets	Elec.2.1.2		
Elec. 2.1.3	Village PV streetlights	Elec.2.1.3		
Elec. 2.1.4	Village small grid line	Elec.2.1.4		
Elec. 2.1.5	Community biogas lighting system	Elec.2.1.5		
Elec. 2.1.6	Others (specify)	Elec.2.1.6		
Q 3.0	**Infrastructure, Facilities and Amenities**			
Q 3.1	**Distance from nearest main facilities (Dis.)**			

Sr. No.	Particulars	Distance (Kms), within village - 0, above 98 kms - Code 99			
Dis.1	All weather road		Dis.1		
Dis.2	Railway Station		Dis.2		
Dis.3	Bus Stop		Dis.3		
Dis.4	District headquarter		Dis.4		
Dis.5	Block/taluka/tehsil headquarter		Dis.5		
Dis.6	Town/city		Dis.6		
Dis.7	Primary School		Dis.7		
Dis.8	Middle School		Dis.8		
Dis.9	High School		Dis.9		
Dis.10	Health facility		Dis.10		

ID Village □□□□

Dis.11	Veterinary facility		Dis.11		□□
Dis.12	Primary agri. co-operative/ credit society		Dis.12		□□
Dis.13	Milk Co-operatives/ Milk collection centre		Dis.13		□□
Dis.14	Market place		Dis.14		□□
Dis.15	Post Office		Dis.15		□□
Dis.16	Telegraph Office		Dis.16		□□
Dis.17	Telephone Office (booth)		Dis.17		□□
Dis.18	Village Panchayat H/Q		Dis.18		□□
Dis.19	V.L.W H/Q		Dis.19		□□
Dis.20	Bank		Dis.20		□□
Dis.21	Petrol Pump		Dis.21		□□
Dis.22	Service centre for agri. equipments		Dis.22		□□
Dis.23	Ration shop		Dis.23		□□
Dis.24	Electrical equipments/ repairs shop		Dis.24		□□
Dis.25	Repair facilities for biogas plants/ improved chulhas		Dis.25		□□
Dis.26	Nearest nursery (tree plantation seedlings)		Dis.26		□□
Dis.27	Firewood market		Dis.27		□□

Other Facilities

Q 3.2	**Educational Facilities**					
Sr. No.	School Type	No.	Number of students			No. of teachers
			Male	Female	Total	
Q3.2.1	Pre-primary	□	□□□	□□□	□□□	□□
Q3.2.2	Primary/ middle(1-7)	□	□□□	□□□	□□□	□□

ID Village

Q3.2.3	Secondary (8-10)					
Q3.2.4	Higher Secondary (11-12)					
Q3.2.5	Others (Specify)					
Q3.2.6	Total in school/ others					

Q 4.0	**Population Characteristics (1991 Census)**			
Q 4.1	Number of households:			
Q 4.1:1	Total	Q 4.1.1		
Q 4.1.2	Scheduled Castes	Q 4.1.2		
Q 4.1.3	Scheduled Tribes	Q 4.1.3		

Q 4.2	Population details (persons)			
Sr. No.	Particulars	Male	Female	Total
Q 4.2.1	S/C			
Q 4.2.2	S/T			
Q 4.2.3	All others			
Q 4.2.4	Total			
Q 4.2.5	Total number of children out of the total population			

Q 4.3 Literate and educated population				
Sr. No.	Particulars	Male	Female	Total
Q 4.3.1	S/C			
Q 4.3.2	S/T			
Q 4.3.3	All Others			
Q 4.3.4	Total			

ID Village

Q 4.4	Occupational distribution of population			
Sr.No.	Particulars	Population		
		Male	Female	Total
Q 4.4.1	Total main workers:-			
Q 4.4.1.1	Cultivators			
Q 4.4.1.2	Agricultural labourers			
Q 4.4.1.3	Household industry - manufacturing, processing, servicing and repairing			
Q 4.4.1.4	Other workers			
Q 4.4.2	Marginal workers			
Q 4.4.3	Non-workers			

Q 5.0	**Agriculture**		
Q 5.1	Land use pattern		
Q 5.1.1	**Land use classification (Aglu)** Year 1994-95		
Sr. No.	Category		Area in Ha.
Aglu.1	Total reporting area	Aglu.1	
Aglu.2	Forest	Aglu.2	
Aglu.3	Barren & non-cultivable land	Aglu.3	
Aglu.4	Land put to non-agricultural uses	Aglu.4	
Algu.5	Permanent pastures and other grazing land	Algu.5	
Aglu.6	Land under misc. tree crops and grooves	Aglu.6	
Aglu.7	Unculturable area (3+4+5+6)	Aglu.7	
Aglu.8	Culturable waste	Aglu.8	
Aglu.9	Current fallow	Aglu.9	
Aglu.10	Other fallow	Aglu.10	
Aglu.11	Net sown area	Aglu.11	

ID Village

Aglu.12	Area sown more than once	Aglu.12	
Aglu.13	Gross cropped area (11+12)	Aglu.13	
Aglu.14	Cultivated area (9+11)	Aglu.14	
Aglu.15	Cutivable area (8+9+10+11)	Aglu.15	
Aglu.16	Area under irrigation	Aglu.16	
Aglu.17	Area under energy plantation	Aglu.17	
Aglu.18	Area under social forestry	Aglu.18	
Aglu.19	Community land :		
Aglu.19.1	a) Owned by panchayat	Aglu.19.1	
Aglu.19.2	b) Govt. revenue land	Aglu.19.2	

Q 5.2	**Land Distribution**		**Year : 1994-95**
Sr. No.	Category/Land Holding Size (Ha.)	No. of households	Total area owned (Ha.)
Q 5.2.1	Large farmers (>3)		
Q 5.2.2	Medium farmers (2-3)		
Q 5.2.3	Small farmers (1-2)		
Q 5.2.4	Marginal farmers (<1)		

Q 5.3	**Cropping Pattern** (List major crops)			Year : 1994-95
Sr. No.	Crops	Irrigated Area (Ha.)	Unirrigated area (Ha.)	Total area (Ha.)
Q 5.3.1	Rice			
Q 5.3.2	Jowar			
Q 5.3.3	Bajara			
Q 5.3.4	Groundnut			
Q 5.3.5	Greengram			
Q 5.3.6	Pigeon Pea			
Q 5.3.7	Other Pulses			

ID Village

Q 5.3.8	Wheat			
Q 5.3.9	Cotton			
Q 5.3.10	Sugarcane			
Q 5.3.11	Mustard			
Q 5.3.12	Maize			
Q 5.3.13	Fodder			
Q 5.3.14	Other			
Q 5.3.15	Other			

Q 5.4	**Irrigation sources and area irrigated**		Year 1994-95	
Sr. No.	Source	Number	Area covered (ha.)	
Q 5.4.1	Canal	N.A		
Q 5.4.2	Tank			
Q 5.4.3	River (lift) :			
Q 5.4.3.1	a) Electrical p.s			
Q 5.4.3.2	b) Diesel p.s			
Q 5.4.4	Dugwells:			
Q 5.4.4.1	a) Manual			
Q 5.4.4.2	b) Animal driven			
Q 5.4.4.3	c) Electrical p.s driven			
Q 5.4.4.4	d) Diesel p.s driven			
Q 5.4.4.5	e) Not used for irrigation		N.A	
Q 5.4.5	Tubewells:			
Q 5.4.5.1	a) Electrical p.s			
Q 5.4.5.2	b) Diesel p.s			
Q 5.4.6	Other sources (specify)			

ID Village

Q 5.5	**Groundwater Details**			
Q 5.5.1	Depth to groundwater table (ft.):			
Q 5.5.1.1	In winter season	Q 5.5.1.1		
Q 5.5.1.2	In summer season	Q 5.5.1.2		
Q 5.5.1.3	In rainy season	Q 5.5.1.3		
Q 5.5.2	Quality of groundwater (1-Sweet 2-Saline)	Q 5.5.2		
Q 5.5.2.1	If saline, was it sweet 5 years back? (1-Yes, 0- No)	Q 5.5.2.1		

Q 5.6	**Livestock Census**			
Sr. No.	Particulars	Adult (3+)	Young (3-)	Total
Q 5.6.1	Cows			
Q 5.6.1.1	Crossbreed			
Q 5.6.1.2	Local			
Q 5.6.1.3	Total			
Q 5.6.2	Bullocks			
Q 5.6.3	Bulls			
Q 5.6.4	Buffaloes (She)			
Q 5.6.4.1	Improved			
Q 5.6.4.2	Local			
Q 5.6.4.3	Total			
Q 5.6.5	Buffaloes (he)			
Q 5.6.6	Sheep	X	X	
Q 5.6.7	Goats	X	X	
Q 5.6.8	Camels	X	X	
Q 5.6.9	Poultry	X	X	
Q 5.6.10	No.of compost pits/heaps	X	X	

ID Village

Q 5.7	Number of agricultural implements (power operated)			
Sr. No.	Type			Number
Q 5.7.1	Tractor :			
Q 5.7.1.1	35 HP	Q 5.7.1.1		
Q 5.7.1.2	55 HP	Q 5.7.1.2		
Q 5.7.1.3	Others (Specify)	Q 5.7.1.3		
Q 5.7.2	Diesel Pumpsets:			
Q 5.7.2.1	2.5 HP	Q 5.7.2.1		
Q 5.7.2.2	5 HP	Q 5.7.2.2		
Q 5.7.2.3	7.5 HP	Q 5.7.2.3		
Q 5.7.2.4	10 HP	Q 5.7.2.4		
Q 5.7.2.5	15 HP	Q 5.7.2.5		
Q 5.7.3	Electrical motor pumpsets			
Q 5.7.3.1	2.5 HP	Q 5.7.3.1		
Q 5.7.3.2	5 HP	Q 5.7.3.2		
Q 5.7.3.3	7.5 HP	Q 5.7.3.3		
Q 5 7.3.4	10 HP	Q 5.7.3.4		
Q 5.7.3.5	15 HP	Q 5.7.3.5		
Q 5.7.4	Submersible pumpsets			
Q 5.7.4.1	5 HP	Q 5.7.4.1		
Q 5.7.4.2	10 HP	Q 5.7.4.2		
Q 5.7.4.3	15 HP	Q 5.7.4.3		
Q 5.7.5	Threshers :			
Q 5.7.5.1	i. Electrical	Q 5.7.5.1		
Q 5.7.5.2	ii. Diesel Engine operatred	Q 5.7.5.2		
Q 5.7.5.3	iii.Tractor operated	Q 5.7.5.3		

ID Village □□□□

Q 5.7.6	Power tillers	Q 5.7.6		□□
Q 5.7.7	Other (specify)	Q 5.7.7		□□
Q 5.7.8	Other (specify)	Q 5.7.8		□□
Q 5.7.9	Other (specify)	Q 5.7.9		□□
Q 5.8	**Pumpsets Rectification in Village**			
Q 5.8.1	Number of pumpsets rectified__________	Q 5.8.1		□□□
Q 5.8.2	Facilities available for repair and maintenance of pump sets 1. Within the village 2. Within the block 3. Within the district	Q 5.8.2		□
Q 5.9	Crop residues used as fuel in the village Codes 1. Cotton Stalk 2. Tur Stalk 3. Paddy Husk 4. 5. 6. 7. 8. 9.	Q 5.9		□□□□
Q 5.10	Predominant local species of trees and shrubs used as fuel Codes 1. 2. 3. 4. 5. 6. 7. 8. 9.	Q 5.10		□□□□

ID Village ☐☐☐☐

Q 6.0	**Artisans Particulars**			
Sr. No.	Category of Artisan			Number
Q 6.1	Carpenter	Q 6.1		☐☐
Q 6.2	Tailor	Q 6.2		☐☐
Q 6.3	Blacksmith	Q 6.3		☐☐
Q 6.4	Potter	Q 6.4		☐☐
Q 6.5	Gold smith	Q 6.5		☐☐
Q 6.6	Mechanic	Q 6.6		☐☐
Q 6.7	Electrician	Q 6.7		☐☐
Q 6.8	Others (Specify)	Q 6.8		☐☐

Q 7.0	**Industries Particulars**				
Sr. No.	Category			Total	No. using electricity
Q 7.1	Flour mills	Q 7.1		☐	☐
Q 7.2	Rice mills	Q 7.2		☐	☐
Q 7.3	Brick kilns	Q 7.3		☐	☐
Q 7.4	Stone crushing units	Q 7.4		☐	☐
Q 7.5	Oil mills/ghanis	Q 7.5		☐	☐
Q 7.6	Other (specify)	Q 7.6		☐	☐
Q 7.7	Other (specify)	Q 7.7		☐	☐

Q 8.0	**Commercial Establishments and Service Workshops**				
Sr. No.	Category (code)*			Number	
				Total	Using Electricity
Q 8.1	☐	Q 8.1		☐	☐
Q 8.2	☐	Q 8.2		☐	☐
Q 8.3	☐	Q 8.3		☐	☐
Q 8.4	☐	Q 8.4		☐	☐
Commercial establishment codes 1-Shop 2-Hotel 3-Pan galla 4-other					

ID Village

Q 9.0	Renewable /Energy Saving Device			
Q 9.1	Village is covered (renewable energy devices are installed) under 1. IREP Programme 2. Urjagram Programme 3. Other renewable energy programme	Q 9.1		

Q 9.2	**Number of Devices**		
Sr. No.	Devices	Total Number	Presently Functioning (Number)
Q 9.2.1	Individual biogas plants		
Q 9.2.2	Improved Chulhas (Fixed)		
Q 9.2.3	Improved Chulhas (Portable)		
Q 9.2.4	Solar cookers		
Q 9.2.5	Pressure Cookers		
Q 9.2.6	SPV Domestic lights		
Q 9.2.7	SPV Lantern		
Q 9.2.8	Solar water heaters		
Q 9.2.9	Solar pumps		
Q 9.2.10	Wind pumps		
Q 9.2.11	Improved bullock carts		
Q 9.2.12	Community biogas plants		
Q 9.2.13	SPV Streetlights		
Q 9.2.14	SPV TV		
Q 9.2.15	SPV Power Plant		
Q 9.2.16	Biomass gasifiers		
Q 9.2.17	Solar refrigerator		
Q 9.2.18	Solar timber kiln		
Q 9.2.19	Improved potter's wheel		
Q 9.2.20	Others (specify)		

ID Village

Q 10.0	Sources of purchasing fuels and prices				
Sr. No.	Fuel	Today's Price (Paise/Kg./litre/No)		Main source of other*	Source distance (kms) (code 0 if available within the village)
		Ration Shop	Other		
Q 10.1	Kerosene (lit)				
Q 10.2	Diesel (lit)	X			
Q.10.3	Petrol (lit)	X			
Q 10.4	Firewood (kg)	X			
Q 10.5	Charcoal (Kg)	X			
Q 10.6	Softcoke (kg)	X			
Q 10.7	Dung Cakes (No.)	X			
Q 10.8	Electricity (kwhr):				
Q 10.8.1	Domestic	X		X	X
Q 10.8.2	Industry	X		X	X
Q 10.8.3	Agriculture				
Q 10.8.3.1	Kwhr.charge	X		X	X
Q 10.8.3.2	Fixed charge per year based on HP:				
Q 10.8.3.2.1	2.5 HP	X		X	X
Q 10.8.3.2.2	5 HP	X		X	X
Q 10.8.3.2.3	10 HP	X		X	X
Q 10.9	LPG Cylinder (Rate per cylinder)	X			

* Main source code .
1. Shop (within village), 2-Hawker (within village), 3-villager (in the same village) 4-Neighbouring village, 5. Neighbouring town

ID Village

Q 11.0	**Wages of Agricultural labour**				
Sr. No.	Particulars	Unit			Cost (Rs.) per Unit
Q 11.1	Labour :				
Q 11.1.1	Male	Rs./day	Q 11.1.1		
Q 11.1.2	Female	Rs./day	Q 11.1.2		
Q 11.1.3	Child	Rs./day	Q 11.1.3		
Q 12.0	**Number of families under poverty line**		Q 12.0		
Q 13.0	**Various Government Programmes currently running in the village**				
Sr. No.	Government Programme (1.Yes 0.No)				
Q 13.1	Agricultural practices & programmes		Q 13 1		
Q 13.2	Health practices and programme		Q 13.2		
Q 13.3	Family planning programme		Q 13.3		
Q 13.4	Village electrification programme		Q 13.4		
Q 13.5	Individual biogas programme		Q 13.5		
Q 13.6	Cummunity biogas programme		Q 13.6		
Q 13.7	Smokeless chulha programme		Q 13.7		
Q 13.8	Social Forestry programme		Q 13.8		
Q 13.9	Rectification of pumpsets programme		Q 13.9		
Q 13.10	Mid-day meal scheme		Q 13.10		
Q 13.11	Drinking water programme		Q 13.11		
Q 13.12	Other programme (specify)		Q 13.12		
Q 13.13	Other programme (specify)		Q 13.13		
Q 13.14	Other programme (specify)		Q 13.14		

VILLAGE LEADER SCHEDULE

INDIA RURAL ENERGY STUDY

Project Code [W][B] [L][S]

State :______________________ [ ]

District :______________________ [ ]

Block :______________________ [ ]

Village :______________________ [ ]

Village Leader Serial No :______________________ [ ]

Name of the village leader:______________________

ID Village Leader :______________________ [ ][ ][ ][ ][ ]

Study Sponsored by

The World Bank, Washington, D.C

Name of the Investigator :______________________

Date :______________________

Verified by :______________________

OPERATIONS RESEARCH GROUP
Baroda 1995

ID Village Leader ☐☐☐☐☐

RURAL ENERGY STUDY
VILLAGE LEADER SCHEDULE

Q 1.0	Indentification			
Q 1.1	State :________________	Q 1.1		☐
Q 1.2	District :____________________	Q 1.2		☐
Q 1.3	Tehsil/Taluka/Block :______________	Q 1.3		☐
Q 1.4	Village :_____________________	Q 1.4		☐
Q 1.5	Village Leader Serial No.:___________	Q 1.5		☐
Q 1 6	**Village Leader's (Respondent's Name)**			
Q 1 6.1	Sex 1. Male 2 Female	Q 1.6.1		☐
Q 1.6.2	Your Designation 1. Panchayat member 2. Co-operative society board member 3. Village Talathi 4. Village level worker 5 Teacher 6. Social Worker 7 Others (Specify)	Q 1.6.2		☐
Q 1.6.3	Your main occupation 1. Farmer 2. Agricultural Labourer 3. Non-agricultural labourer 4. Artisan 5. Housewife 6. Other (Business, service)	Q 1.6.3		☐
Q 1.6.4	Your formal education 1. None 2. Grade 1-4 3. Grade 5-8 4 Grade 9-12 5. Above grade 12	Q 1.6.4		☐

ID Village Leader

Q 2.0	**Agriculture**		
Q 2.1	**Agricultural Inputs**		
Sr. No	Items	Used in village today Yes No 1 0	If yes, compared to 5 years ago has consumption/ use during 1994-95: 1-gone up 2-remained static 3-Gone down
Q 2.1.1	Organic Fertilizers		
Q 2.1.2	Green Fertilizers		
Q 2.1.3	Chemical Fertilizers		
Q 2.1.4	Improved/HYV Seeds		
Q 2.1.5	Diesel Pumpsets		
Q 2.1.6	Electric Pumpsets		
Q 2.1.7	Other electric/diesel operated agric. implements		

Q. 2.2	Farmgate prices of major crops (Rs./Qt.)	
Sr No.	Crops	Farmgate Price(Rs./Qt.)
Q 2 2.1		
Q 2.2.2		
Q 2.2.3		
Q 2 2.4		
Q 2.2.5		
Q 2 2.6		
Q 2.2.7		
Q 2.2.8		
	Note : Do not fill crop codes	

ID Village Leader

Q 2.3	**Rectification of Agricultural Pumpsets**			
Q 2.3 1	Are farmers aware of government programme for rectification of pumpsets? 1. Fully informed about the programme and taken action 2. Aware, but not taken action 3. Never heard of it	Q 2.3.1		
Q 3.0	**Electrification (Elec.)**			
Elec.1	Is the village electrified? Yes-1, No-0 If no, go to 4.0	Elec.1		
Elec.2	If yes, for what purpose? 1. Domestic 2. Agriculture 3. Both	Elec.2		
Elec.3	Over the past one month how many times has the current failed? (Number)			
Elec.3.1	Domestic	Elec.3.1		
Elec.3.2	Agriculture	Elec.3.2		
Elec.4	The electrical connections in this village have gone to 1. Anyone who wanted it 2. Mainly to influential people	Elec.4		
Q 4.0	**Credit/Loan Facilities**			
Q 4.1	Number of farmers applied for loans last year?	Q 4.1		
Q 4.2	How many of them got loans?	Q 4.2		
Q 4.3	Credit facilities available are : 1. Adequate 2. Inadequate 3. Don't know	Q 4.3		
Q 4.4	How easy is it for farmers to get loans from various agencies? 0. Not applicable 1. Difficult 2. Easy 3. Don't know			
Q 4.4.1	Co-operative Bank	Q 4.4.1		
Q 4.4.2	Regional Rural Bank	Q 4.4.2		

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Q 4.4 3	Commerical bank	Q 4.4.3		☐
Q 4.4.4	Money Lenders	Q 4.4.4		☐
Q 4.4.5	Others (Specify)	Q 4.4.5		☐
Q 4.5	Do villagers apply for loans for electricial pumpsets/other electrical appliances? Yes-1, No-0	Q 4 5		☐
Q 5.0	**Various Development Programmes**			
Q 5.1	**Success Rating of programme** Rating : Codes : 0. Programme does not exist 1. Unsuccessful 2. Successful 3. Don't know/No opinion			
Q 5.1.1	Health Programme	Q 5.1.1		☐
Q 5 1.2	Family Planning Programme	Q 5.1.2		☐
Q 5.1.3	Immunization Programme	Q 5.1.3		☐
Q 5.1.4	Village Electrification Programme	Q 5.1.4		☐
Q 5.1.5	Agricultural Improvement Programme	Q 5.1.5		☐
Q 5.1.6	Mid-day meal (Nutrition) Programme	Q 5.1.6		☐
Q 5.1.7	Women's Welfare Programme	Q 5.1.7		☐
Q 5.1 8	Individual Biogas Programme	Q 5.1.8		☐
Q 5.1.9	Community biogas programme	Q 5 1.9		☐
Q 5.1.10	Smokeless chulha programme	Q 5 1.10		☐
Q 5.1.11	Social forestry programme	Q 5.1.11		☐
Q 5.1.12	Rectification of agricultural pumping systems	Q 5.1.12		☐
Q 5.1.13	Other (specify)	Q 5.1.13		☐
Q 5 1.14	Other (specify)	Q 5.1.14		☐
Q 5.1.15	Other (specify)	Q 5.1.15		☐

ID Village Leader

	Opinion and Attitude			
Q 6.0	**Opinion (OP)**			
OP 1	**Opinions regarding various officials** Codes : 1. Not helpful 2. Helpful 3. Don't know/No opinion			
OP 1.1	VLW	OP 1.1		☐
OP 1.2	Talathi	OP 1.2		☐
OP 1.3	PHC - Doctor	OP 1.3		☐
OP 1.4	B.D.O	OP 1.4		☐
OP 1.5	AEO (Agri.)	OP 1.5		☐
OP 1.6	CEO (Co.Op)	OP 1.6		☐
OP 1.7	Veterinary Doctor	OP 1.7		☐
OP 1.8	School Teachers	OP 1.8		☐
OP 1.9	Village Co.Op Officials	OP 1.9		☐
OP 1.10	Forest/Ranger officer	OP 1.10		☐
OP 1.11	Sub-Divisional Electricity Official	OP 1.11		☐
OP.2	Would most people in this village encourage or discourage a housewife who wanted to learn, read or write? 1. Encourage 2. Discourage 3. Would not care 4. Do not know	OP 2		☐
OP.3	Do you think that availability of the following fuels (outside home for free collecting) has declined or increased as compared to past years? Codes : 1. Declined 2. No change 3. Increased 4. No opinion			
OP 3.1	Dung	OP 3 1		☐
OP 3.2	Firewood	OP 3 2		☐
OP 3.3	Straw	OP 3.3		☐

ID Village Leader

OP 3.4	Kerosene	OP 3.4		☐
OP 3.5	LPG	OP 3 5		☐
OP 4	Do you agree with the following statements? 1. Yes, 0. No, 2 No opinion			
OP 4.1	Fuelwood is in great shortage	OP 4.1		☐
OP 4.2	There are few trees today in the village	OP 4.2		☐
OP 4.3	In the future fuelwood will be even more scarce than today	OP 4.3		☐
OP 4.4	More trees should be planted in future	OP 4.4		☐
OP 4.5	Farmers should plant more trees	OP 4.5		☐
OP 4.6	Burning dung does not take fertlizer away from agricultural fields	OP 4.6		☐
OP 4 7	Using electricity is too expensive for lighting	OP 4.7		☐
OP 4.8	Using electricity is not reliable for lighting	OP 4.8		☐
OP 4.9	Using electricity is too expensive for irrigation	OP 4.9		☐
OP 4.10	Using electricity is not reliable for irrigation	OP 4.10		☐
OP 4.11	I would be willing to pay more for electricity if there were few power cuts and dimming	OP 4.11		☐
OP 4.12	It is better to have agricultural pumpset meters alongwith very reliable supply of electricity rather than fixed rates (no meter) at current level of supply	OP 4.12		☐
OP 4.13	Electricity is more expensive than kerosene for lighting	OP 4.13		☐
OP 5	Rank major problems faced in the village : Problem code : 0. No. Problem 1. Minor Problem 2. Major Problem 3. No opinion			
OP 5.1	Lack of adequate drinking water facilities	OP 5.1		☐
OP 5.2	Lack of adequate irrigation facilities	OP 5.2		☐

ID Village Leader

OP 5.3	Lack of approach road	OP 5.3		☐
OP 5.4	Lack of communication facilities	OP 5.4		☐
OP 5.5	Lack of health care	OP 5.5		☐
OP 5.6	Lack of service/repair/ maintenance facilities	OP 5.6		☐
OP 5.7	Lack of adequate electricity supplies	OP 5.7		☐
OP 5 8	Lack of adequate kerosene supplies	OP 5.8		☐
OP 5.9	Lack of adequate LPG supplies	OP 5.9		☐
OP 5.10	Lack of availability of agricultural inputs	OP 5.10		☐
OP 5.11	Shortage of fuels available for cooking	OP 5.11		☐
OP 5.12	Other Problem (specify)	OP 5.12		☐
OP 5.13	Other Problem (specify)	OP 5.13		☐

ID Village Leader

Q 7 0	Marketing of Renewables Energy Devices							
Q 7 1	**Awareness and willingness to purchase Community/Institutional Renewable Energy Devices** · What is your level of knowledge and interest in the following technologies? Codes : 1. Yes 0 No 2 Don't Know							
Sr No	Technology	Already owns it	Heard about it	Available in market	Interested in purchasing without credit	Interested in purchasing with credit	Not interested	If owns/ purchased amount paid* (Rs)
7 1 1	Community biogas plant							
7 1 2	Nightsoil based biogas plant							
7 1 3	Community improved chulha							
7.1 4	Community solar cooker							
7 1 5	SPV streetlights							
7.1 6	SPV television							
7 1 7	SPV pump							
7 1 8	Solar refrigerator							
7 1 9	Solar telephone							
7.1.10	Wind pump							
7.1.11	Wind mill							
7 1 12	Biomass gasifier							

* Notes Code 222 . if device owned, but does not know price
Code 000 . . if 100% subsidized
Code 888 . . if not applicable

ID Village Leader

7.2	Whether renewable energy programme has created additional employment in the village? 1. Yes 0. No	7.2		
7.3	If yes, number of mandays employment created	7.3		
7.4	Do women participate in renewable energy programme? 1. Yes 0. No	7.4		

ARTISAN SCHEDULE

INDIA RURAL ENERGY STUDY

Project Code

W	B
A	S

State : ______________________ ☐

District : ______________________ ☐

Block : ______________________ ☐

Village : ______________________ ☐

Artisan No. : ______________________ ☐☐

Name and Type of Artisanal Activity . ______________________

ID Artisan · ______________________ ☐☐☐☐☐☐

Study Sponsored by

The World Bank, Washington, D.C

Name of the Investigator . ______________________

Date : ______________________

Verified by : ______________________

OPERATIONS RESEARCH GROUP
Baroda 1995

ID Artisan

RURAL ENERGY STUDY
ARTISAN SCHEDULE

Q 1.0	**Identification**			
Q 1.1	State ____________	Q 1.1		☐
Q 1.2	District ____________	Q 1.2		☐
Q 1.3	Tehsil/Taluka/Block ________	Q 1.3		☐
Q 1.4	Village ____________	Q 1.4		☐
Q 1.5	Artisan No. ________	Q 1.5		☐☐
Q 1.6	Type of Artisan________ Codes: 1. Carpenter, 2. Tailor 3. Balck smith, 4. Goldsmith 5. Potter, 6. Basket maker 7. Weaver, 8. Craft maker 9. Cobbler, 10.Barber 11.Other (specify)	Q 1.6		☐☐
Q 1.7	Years ago adopted electricity : (Code 00 if no electricity)	Q 1.7		☐☐
Q 1.8	Name of Respondent and Status : ____________	Q 1.8		
Q 2.0	**Capacity and Production**			
Q 2.1	Is it seasonal or year round? (1-Seasonal, 2-Year round)	Q 2.1		☐
Q 2.1.1	If seasonal, period of operation (indicate months)	Q 2.1.1		☐☐

JAN	FEB	MAR	APR	MAY	JUNE	JULY
AUG	**SEP**	**OCT**	**NOV**	**DEC.**		

ID Artisan

Q 2 2	During the last year which products did you manufacture? What was the annual volume of production?			
Sr. No.	Product	Unit	Cost per unit (Rs.)	Annual Production
Q 2.2.1				
Q 2.2.2				
Q 2.2.3				
Q 2.2.4				

Q 3.0 Energy used in production :

Q 3 1 Energy consumption during last one working month :

Sr. No.	Particulars	Human Labour (days)			Animal Labour (Bullock pair days)	Electricity (Kwhr.)
		Male	Female	Child		
Q 3.1.1	Units consumed					
Q 3.1.2	Rate per unit (Rs.)					

Sr. No.	Particulars	Diesel (Lit)	Coal/ charcoal	Fire wood (Kgs)	Agri. wastes (Kgs)	Any other (Specify)
Q 3.1.1	Units Consumed					
Q 3.1.2	Rate per unit (Rs.)					

One man/woman/child day = 8 hours

Q 3.2	What fraction of your cost of production is taken up for energy? ____________ percent	Q 3.2		

ID Artisan

Q.4.0	What is your main energy problem?
Q.5.0	What do you plan to do about it?
Q.6.0	Who should help/what should be done to help you for your energy problem?

ID Artisan ☐☐☐☐☐☐

Q.7.0	What needs to be done so that renewable energy might be helpful to you?			
Q 8.0	**Opinion and attitude** (Please give your opinion concerning the following statements) Codes : 1. Strongly agree 2. Agree 3. No opinion 4. Disagree 5. Strongly disagree			
Q 8.1	There is a great potential for energy conservation in this artisanal activity	Q 8.1		☐
Q 8.2	Energy conservation would require too much expenditure	Q 8.2		☐
Q 8.3	Government Organisations assist me in my business	Q 8.3		☐
Q 8.4	Government programmes are useful for my business	Q 8.4		☐
Q 8.5	Government subsidies are necessary for my business	Q 8.5		☐
Q 8.6	Ask these only to those who do not use electricity. We do not use electricity because: 1. Village is not electrified 2. Electricity is too expensive 3. Supply of electricity is irregular 4. Applied for connection, but yet to get it 5. Not necessary for my business 6. Other	Q 8.6		☐

INDUSTRY SCHEDULE

INDIA RURAL ENERGY STUDY

Project Code

W	B
I	A

State : ____________________

District : ____________________

Block : ____________________

Village : ____________________

Industry No. : ____________________

Name of the Industry : ____________________

ID Industry : ____________________

Study Sponsored by

The World Bank, Washington, D.C

Name of the Investigator : ____________________

Date : ____________________

Verified by : ____________________

OPERATIONS RESEARCH GROUP
Baroda 1995

ID Industry ☐☐☐☐☐☐

RURAL ENERGY STUDY
INDUSTRY SCHEDULE

Q 1.0	**Identification**			
Q 1.1	State ____________	Q 1.1		☐
Q 1.2	District ____________	Q 1.2		☐
Q 1.3	Tehsil/Taluka/Block ____________	Q 1.3		☐
Q 1.4	Village ____________	Q 1.4		☐
Q 1.5	Industry No.	Q 1.5		☐☐
Q 1.6	Type of Industry Codes: 1. Flour Mill 2. Stone Crushing Unit 3. Oil Mill/Ghani 4. Bakery 5. Rice Mill 6. Brick Kiln 7. Others (specify)	Q 1.6		☐
Q 1.7	**Name of Establishment/Unit** :____________	Q 1.7		
Q 1.8	Years ago established	Q 1.8		☐☐
Q 1.9	Years ago adopted electricity : ________ (code 00 if no electricity)	Q 1.9		☐☐
Q 1.10	Nature of ownership (1-Proprietorship, 2-Partnership, 3-Co-oeprative, 4-Pvt. Ltd. Co., 5-Public Ltd., Co.)	Q 1.10		☐
Q 1.11	Registration Status (1-Registered, 2-Not Registered)	Q 1.11		☐
Q 1.12	Source of lighting (1-Electricity, 2-Kerosene, 0-Not Required)	Q 1.12		☐
Q 1.13	Capital investment/assets (in '000 Rs.)	Q 1.13		☐☐
Q 1.14	Name of Respondent and Status : ____________	Q 1.14		

ID Industry

Q 2.0	Capacity and Production			
Q 2.1	Is it seasonal or year round? (1-Seasonal, 2-Year round)	Q 2.1		
Q 2 1.1	If seasonal, period of operation (indicate months)	Q 2.1.1		

JAN	FEB	MAR	APR	MAY	JUNE	JUL	AUG	SEP	OCT	NOV	DEC

Q 2.2 During the last year which products did you manufacture? What was the annual volume of production?

Sr. No.	Product (Code the product)	Unit	Cost per Unit (Paise)	Annual Production
Q 2.2.1				
Q 2.2.2				
Q 2.2.3				
Q 2 2.4				

Product Code :
1. Grain flour
2. Crushed stone
3. Extracted Oil
4 Rice
5. Bricks
6. Breads
7. Other (specify)
8. Other (specify)
9. Other (specify)

Q 3.0 Energy forms used in manufacturing/processing :

Q 3.1 Energy consumption during last one working month :

Sr. No.	Particulars	Human Labour (days)			Animal Labour (Bullock Pair days)	Electricity (kwhr.)
		Male	Female	Child		
Q 3.1.1	Units consumed					
Q 3 1.2	Rate per unit (Rs.)					

ID Industry

Sr. No.	Particulars	Diesel (Lit)	Coal/ charcoal	Fire wood (Kgs)	Agri. Wastes (Kgs)	Any other (Specify)
Q 3.1.1	Units Consumed					
Q 3.1.2	Rate per units (Rs.)					
One man/woman/child day = 8 hours						
Q 3 2	What fraction of your cost of production is taken up by fuel energy ? ____________ percent			Q 3.2		

Q.4.0 What is your main energy problem?

Q.5.0 What do you plan to do about it?

Q 6.0 Who should help/what should be done to help you for your energy problem?

ID Industry

Q 7.0	What needs to be done so that renewable energy might be helpful to you?			
Q 8.0	**Opinion and attitude** (Please give your opinion concerning the following statements) Codes : 1. Strongly agree 2. Agree 3. No opinion 4. Disagree 5. Strongly disagree			
Q 8.1	There is a great potential for energy conservation in this industry	Q 8.1		☐
Q 8.2	Energy conservation is affordable	Q 8.2		☐
Q 8.3	Government Organisations assist me in my business	Q 8.3		☐
Q 8.4	Government programmes are useful for my business	Q 8.4		☐
Q 8.5	Government subsidies are necessary for my business	Q 8.5		☐
Q 8.6	Ask these only to those who do not use electricity. We do not use electricity because: 1. Village is not electrified 2. Electricity is too expensive 3. Supply of electricity is irregular 4. Applied for connection, but yet to get it 5. Not necessary for my business 6. Other reason	Q 8.6		☐

Joint UNDP/World Bank

ENERGY SECTOR MANAGEMENT ASSISTANCE PROGRAMME (ESMAP)

LIST OF REPORTS ON COMPLETED ACTIVITIES

Region/Country	*Activity/Report Title*	*Date*	*Number*
	SUB-SAHARAN AFRICA (AFR)		
Africa Regional	Anglophone Africa Household Energy Workshop (English)	07/88	085/88
	Regional Power Seminar on Reducing Electric Power System Losses in Africa (English)	08/88	087/88
	Institutional Evaluation of EGL (English)	02/89	098/89
	Biomass Mapping Regional Workshops (English)	05/89	--
	Francophone Household Energy Workshop (French)	08/89	--
	Interafrican Electrical Engineering College: Proposals for Short- and Long-Term Development (English)	03/90	112/90
	Biomass Assessment and Mapping (English)	03/90	--
	Symposium on Power Sector Reform and Efficiency Improvement in Sub-Saharan Africa (English)	06/96	182/96
	Commercialization of Marginal Gas Fields (English)	12/97	201/97
	Commercilizing Natural Gas: Lessons from the Seminar in Nairobi for Sub-Saharan Africa and Beyond	01/00	225/00
	Africa Gas Initiative – Main Report: Volume I	02/01	240/01
	First World Bank Workshop on the Petroleum Products Sector in Sub-Saharan Africa	09/01	245/01
	Ministerial Workshop on Women in Energy	10/01	250/01
Angola	Energy Assessment (English and Portuguese)	05/89	4708-ANG
	Power Rehabilitation and Technical Assistance (English)	10/91	142/91
	Africa Gas Initiative – Angola: Volume II	02/01	240/01
Benin	Energy Assessment (English and French)	06/85	5222-BEN
Botswana	Energy Assessment (English)	09/84	4998-BT
	Pump Electrification Prefeasibility Study (English)	01/86	047/86
	Review of Electricity Service Connection Policy (English)	07/87	071/87
	Tuli Block Farms Electrification Study (English)	07/87	072/87
	Household Energy Issues Study (English)	02/88	--
	Urban Household Energy Strategy Study (English)	05/91	132/91
Burkina Faso	Energy Assessment (English and French)	01/86	5730-BUR
	Technical Assistance Program (English)	03/86	052/86
	Urban Household Energy Strategy Study (English and French)	06/91	134/91
Burundi	Energy Assessment (English)	06/82	3778-BU
	Petroleum Supply Management (English)	01/84	012/84
	Status Report (English and French)	02/84	011/84
	Presentation of Energy Projects for the Fourth Five-Year Plan (1983-1987) (English and French)	05/85	036/85
	Improved Charcoal Cookstove Strategy (English and French)	09/85	042/85
	Peat Utilization Project (English)	11/85	046/85
	Energy Assessment (English and French)	01/92	9215-BU
Cameroon	Africa Gas Initiative – Cameroon: Volume III	02/01	240/01
Cape Verde	Energy Assessment (English and Portuguese)	08/84	5073-CV
	Household Energy Strategy Study (English)	02/90	110/90
Central African Republic	Energy Assessement (French)	08/92	9898-CAR
Chad	Elements of Strategy for Urban Household Energy The Case of N'djamena (French)	12/93	160/94

Region/Country	*Activity/Report Title*	*Date*	*Number*
Comoros	Energy Assessment (English and French)	01/88	7104-COM
	In Search of Better Ways to Develop Solar Markets: The Case of Comoros	05/00	230/00
Congo	Energy Assessment (English)	01/88	6420-COB
	Power Development Plan (English and French)	03/90	106/90
	Africa Gas Initiative – Congo: Volume IV	02/01	240/01
Côte d'Ivoire	Energy Assessment (English and French)	04/85	5250-IVC
	Improved Biomass Utilization (English and French)	04/87	069/87
	Power System Efficiency Study (English)	12/87	--
	Power Sector Efficiency Study (French)	02/92	140/91
	Project of Energy Efficiency in Buildings (English)	09/95	175/95
	Africa Gas Initiative – Côte d'Ivoire: Volume V	02/01	240/01
Ethiopia	Energy Assessment (English)	07/84	4741-ET
	Power System Efficiency Study (English)	10/85	045/85
	Agricultural Residue Briquetting Pilot Project (English)	12/86	062/86
	Bagasse Study (English)	12/86	063/86
	Cooking Efficiency Project (English)	12/87	--
	Energy Assessment (English)	02/96	179/96
Gabon	Energy Assessment (English)	07/88	6915-GA
	Africa Gas Initiative – Gabon: Volume VI	02/01	240/01
The Gambia	Energy Assessment (English)	11/83	4743-GM
	Solar Water Heating Retrofit Project (English)	02/85	030/85
	Solar Photovoltaic Applications (English)	03/85	032/85
	Petroleum Supply Management Assistance (English)	04/85	035/85
Ghana	Energy Assessment (English)	11/86	6234-GH
	Energy Rationalization in the Industrial Sector (English)	06/88	084/88
	Sawmill Residues Utilization Study (English)	11/88	074/87
	Industrial Energy Efficiency (English)	11/92	148/92
Guinea	Energy Assessment (English)	11/86	6137-GUI
	Household Energy Strategy (English and French)	01/94	163/94
Guinea-Bissau	Energy Assessment (English and Portuguese)	08/84	5083-GUB
	Recommended Technical Assistance Projects (English & Portuguese)	04/85	033/85
	Management Options for the Electric Power and Water Supply Subsectors (English)	02/90	100/90
	Power and Water Institutional Restructuring (French)	04/91	118/91
Kenya	Energy Assessment (English)	05/82	3800-KE
	Power System Efficiency Study (English)	03/84	014/84
	Status Report (English)	05/84	016/84
	Coal Conversion Action Plan (English)	02/87	--
	Solar Water Heating Study (English)	02/87	066/87
	Peri-Urban Woodfuel Development (English)	10/87	076/87
	Power Master Plan (English)	11/87	--
	Power Loss Reduction Study (English)	09/96	186/96
	Implementation Manual: Financing Mechanisms for Solar Electric Equipment	07/00	231/00
Lesotho	Energy Assessment (English)	01/84	4676-LSO
Liberia	Energy Assessment (English)	12/84	5279-LBR
	Recommended Technical Assistance Projects (English)	06/85	038/85
	Power System Efficiency Study (English)	12/87	081/87
Madagascar	Energy Assessment (English)	01/87	5700-MAG
	Power System Efficiency Study (English and French)	12/87	075/87

Region/Country	*Activity/Report Title*	*Date*	*Number*
Madagascar	Environmental Impact of Woodfuels (French)	10/95	176/95
Malawi	Energy Assessment (English)	08/82	3903-MAL
	Technical Assistance to Improve the Efficiency of Fuelwood Use in the Tobacco Industry (English)	11/83	009/83
	Status Report (English)	01/84	013/84
Mali	Energy Assessment (English and French)	11/91	8423-MLI
	Household Energy Strategy (English and French)	03/92	147/92
Islamic Republic of Mauritania	Energy Assessment (English and French)	04/85	5224-MAU
	Household Energy Strategy Study (English and French)	07/90	123/90
Mauritius	Energy Assessment (English)	12/81	3510-MAS
	Status Report (English)	10/83	008/83
	Power System Efficiency Audit (English)	05/87	070/87
	Bagasse Power Potential (English)	10/87	077/87
	Energy Sector Review (English)	12/94	3643-MAS
Mozambique	Energy Assessment (English)	01/87	6128-MOZ
	Household Electricity Utilization Study (English)	03/90	113/90
	Electricity Tariffs Study (English)	06/96	181/96
	Sample Survey of Low Voltage Electricity Customers	06/97	195/97
Namibia	Energy Assessment (English)	03/93	11320-NAM
Niger	Energy Assessment (French)	05/84	4642-NIR
	Status Report (English and French)	02/86	051/86
	Improved Stoves Project (English and French)	12/87	080/87
	Household Energy Conservation and Substitution (English and French)	01/88	082/88
Nigeria	Energy Assessment (English)	08/83	4440-UNI
	Energy Assessment (English)	07/93	11672-UNI
Rwanda	Energy Assessment (English)	06/82	3779-RW
	Status Report (English and French)	05/84	017/84
	Improved Charcoal Cookstove Strategy (English and French)	08/86	059/86
	Improved Charcoal Production Techniques (English and French)	02/87	065/87
	Energy Assessment (English and French)	07/91	8017-RW
	Commercialization of Improved Charcoal Stoves and Carbonization Techniques Mid-Term Progress Report (English and French)	12/91	141/91
SADC	SADC Regional Power Interconnection Study, Vols. I-IV (English)	12/93	-
SADCC	SADCC Regional Sector: Regional Capacity-Building Program for Energy Surveys and Policy Analysis (English)	11/91	-
Sao Tome and Principe	Energy Assessment (English)	10/85	5803-STP
Senegal	Energy Assessment (English)	07/83	4182-SE
	Status Report (English and French)	10/84	025/84
	Industrial Energy Conservation Study (English)	05/85	037/85
	Preparatory Assistance for Donor Meeting (English and French)	04/86	056/86
	Urban Household Energy Strategy (English)	02/89	096/89
	Industrial Energy Conservation Program (English)	05/94	165/94
Seychelles	Energy Assessment (English)	01/84	4693-SEY
	Electric Power System Efficiency Study (English)	08/84	021/84
Sierra Leone	Energy Assessment (English)	10/87	6597-SL
Somalia	Energy Assessment (English)	12/85	5796-SO
Republic of South Africa	Options for the Structure and Regulation of Natural Gas Industry (English)	05/95	172/95

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Sudan	Management Assistance to the Ministry of Energy and Mining	05/83	003/83
	Energy Assessment (English)	07/83	4511-SU
	Power System Efficiency Study (English)	06/84	018/84
	Status Report (English)	11/84	026/84
	Wood Energy/Forestry Feasibility (English)	07/87	073/87
Swaziland	Energy Assessment (English)	02/87	6262-SW
	Household Energy Strategy Study	10/97	198/97
Tanzania	Energy Assessment (English)	11/84	4969-TA
	Peri-Urban Woodfuels Feasibility Study (English)	08/88	086/88
	Tobacco Curing Efficiency Study (English)	05/89	102/89
	Remote Sensing and Mapping of Woodlands (English)	06/90	--
	Industrial Energy Efficiency Technical Assistance (English)	08/90	122/90
	Power Loss Reduction Volume 1: Transmission and Distribution SystemTechnical Loss Reduction and Network Development (English)	06/98	204A/98
	Power Loss Reduction Volume 2: Reduction of Non-Technical Losses (English)	06/98	204B/98
Togo	Energy Assessment (English)	06/85	5221-TO
	Wood Recovery in the Nangbeto Lake (English and French)	04/86	055/86
	Power Efficiency Improvement (English and French)	12/87	078/87
Uganda	Energy Assessment (English)	07/83	4453-UG
	Status Report (English)	08/84	020/84
	Institutional Review of the Energy Sector (English)	01/85	029/85
	Energy Efficiency in Tobacco Curing Industry (English)	02/86	049/86
	Fuelwood/Forestry Feasibility Study (English)	03/86	053/86
	Power System Efficiency Study (English)	12/88	092/88
	Energy Efficiency Improvement in the Brick and Tile Industry (English)	02/89	097/89
	Tobacco Curing Pilot Project (English)	03/89	UNDP Terminal Report
	Energy Assessment (English)	12/96	193/96
	Rural Electrification Strategy Study	09/99	221/99
Zaire	Energy Assessment (English)	05/86	5837-ZR
Zambia	Energy Assessment (English)	01/83	4110-ZA
	Status Report (English)	08/85	039/85
	Energy Sector Institutional Review (English)	11/86	060/86
	Power Subsector Efficiency Study (English)	02/89	093/88
	Energy Strategy Study (English)	02/89	094/88
	Urban Household Energy Strategy Study (English)	08/90	121/90
Zimbabwe	Energy Assessment (English)	06/82	3765-ZIM
	Power System Efficiency Study (English)	06/83	005/83
	Status Report (English)	08/84	019/84
	Power Sector Management Assistance Project (English)	04/85	034/85
	Power Sector Management Institution Building (English)	09/89	--
	Petroleum Management Assistance (English)	12/89	109/89
	Charcoal Utilization Prefeasibility Study (English)	06/90	119/90
	Integrated Energy Strategy Evaluation (English)	01/92	8768-ZIM
	Energy Efficiency Technical Assistance Project: Strategic Framework for a National Energy Efficiency Improvement Program (English)	04/94	--
	Capacity Building for the National Energy Efficiency Improvement Programme (NEEIP) (English)	12/94	--

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Zimbabwe	Rural Electrification Study	03/00	228/00

EAST ASIA AND PACIFIC (EAP)

Region/Country	*Activity/Report Title*	*Date*	*Number*
Asia Regional	Pacific Household and Rural Energy Seminar (English)	11/90	--
China	County-Level Rural Energy Assessments (English)	05/89	101/89
	Fuelwood Forestry Preinvestment Study (English)	12/89	105/89
	Strategic Options for Power Sector Reform in China (English)	07/93	156/93
	Energy Efficiency and Pollution Control in Township and Village Enterprises (TVE) Industry (English)	11/94	168/94
	Energy for Rural Development in China: An Assessment Based on a Joint Chinese/ESMAP Study in Six Counties (English)	06/96	183/96
	Improving the Technical Efficiency of Decentralized Power Companies	09/99	222/99
Fiji	Energy Assessment (English)	06/83	4462-FIJ
Indonesia	Energy Assessment (English)	11/81	3543-IND
	Status Report (English)	09/84	022/84
	Power Generation Efficiency Study (English)	02/86	050/86
	Energy Efficiency in the Brick, Tile and Lime Industries (English)	04/87	067/87
	Diesel Generating Plant Efficiency Study (English)	12/88	095/88
	Urban Household Energy Strategy Study (English)	02/90	107/90
	Biomass Gasifier Preinvestment Study Vols. I & II (English)	12/90	124/90
	Prospects for Biomass Power Generation with Emphasis on Palm Oil, Sugar, Rubberwood and Plywood Residues (English)	11/94	167/94
Lao PDR	Urban Electricity Demand Assessment Study (English)	03/93	154/93
	Institutional Development for Off-Grid Electrification	06/99	215/99
Malaysia	Sabah Power System Efficiency Study (English)	03/87	068/87
	Gas Utilization Study (English)	09/91	9645-MA
Mongolia	Energy Efficiency in the Electricity and District Heating Sectors	10/01	247/01
	Improved Space Heating Stoves for Ulaanbaatar	03/02	254/02
Myanmar	Energy Assessment (English)	06/85	5416-BA
Papua New Guinea	Energy Assessment (English)	06/82	3882-PNG
	Status Report (English)	07/83	006/83
	Institutional Review in the Energy Sector (English)	10/84	023/84
	Power Tariff Study (English)	10/84	024/84
Philippines	Commercial Potential for Power Production from Agricultural Residues (English)	12/93	157/93
	Energy Conservation Study (English)	08/94	--
	Strengthening the Non-Conventional and Rural Energy Development Program in the Philippines: A Policy Framework and Action Plan	08/01	243/01
	Rural Electrification and Development in the Philippines: Measuring the Social and Economic Benefits	05/02	255/02
Solomon Islands	Energy Assessment (English)	06/83	4404-SOL
	Energy Assessment (English)	01/92	979-SOL
South Pacific	Petroleum Transport in the South Pacific (English)	05/86	--
Thailand	Energy Assessment (English)	09/85	5793-TH
	Rural Energy Issues and Options (English)	09/85	044/85

Region/Country	*Activity/Report Title*	*Date*	*Number*
Thailand	Accelerated Dissemination of Improved Stoves and Charcoal Kilns (English)	09/87	079/87
	Northeast Region Village Forestry and Woodfuels Preinvestment Study (English)	02/88	083/88
	Impact of Lower Oil Prices (English)	08/88	--
	Coal Development and Utilization Study (English)	10/89	--
Tonga	Energy Assessment (English)	06/85	5498-TON
Vanuatu	Energy Assessment (English)	06/85	5577-VA
Vietnam	Rural and Household Energy-Issues and Options (English)	01/94	161/94
	Power Sector Reform and Restructuring in Vietnam: Final Report to the Steering Committee (English and Vietnamese)	09/95	174/95
	Household Energy Technical Assistance: Improved Coal Briquetting and Commercialized Dissemination of Higher Efficiency Biomass and Coal Stoves (English)	01/96	178/96
	Petroleum Fiscal Issues and Policies for Fluctuating Oil Prices In Vietnam	02/01	236/01
	An Overnight Success: Vietnam's Switch to Unleaded Gasoline	08/02	257/02
Western Samoa	Energy Assessment (English)	06/85	5497-WSO

SOUTH ASIA (SAS)

Bangladesh	Energy Assessment (English)	10/82	3873-BD
	Priority Investment Program (English)	05/83	002/83
	Status Report (English)	04/84	015/84
	Power System Efficiency Study (English)	02/85	031/85
	Small Scale Uses of Gas Prefeasibility Study (English)	12/88	--
	Reducing Emissions from Baby-Taxis in Dhaka	01/02	253/02
India	Opportunities for Commercialization of Nonconventional Energy Systems (English)	11/88	091/88
	Maharashtra Bagasse Energy Efficiency Project (English)	07/90	120/90
	Mini-Hydro Development on Irrigation Dams and Canal Drops Vols. I, II and III (English)	07/91	139/91
	WindFarm Pre-Investment Study (English)	12/92	150/92
	Power Sector Reform Seminar (English)	04/94	166/94
	Environmental Issues in the Power Sector (English)	06/98	205/98
	Environmental Issues in the Power Sector: Manual for Environmental Decision Making (English)	06/99	213/99
	Household Energy Strategies for Urban India: The Case of Hyderabad	06/99	214/99
	Greenhouse Gas Mitigation In the Power Sector: Case Studies From India	02/01	237/01
	Energy Strategies for Rural India: Evidence from Six States	08/02	258/02
Nepal	Energy Assessment (English)	08/83	4474-NEP
	Status Report (English)	01/85	028/84
	Energy Efficiency & Fuel Substitution in Industries (English)	06/93	158/93
Pakistan	Household Energy Assessment (English)	05/88	--
	Assessment of Photovoltaic Programs, Applications, and Markets (English)	10/89	103/89
	National Household Energy Survey and Strategy Formulation Study: Project Terminal Report (English)	03/94	--
	Managing the Energy Transition (English)	10/94	--

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Pakistan	Lighting Efficiency Improvement Program		
	Phase 1: Commercial Buildings Five Year Plan (English)	10/94	--
	Clean Fuels	10/01	246/01
Sri Lanka	Energy Assessment (English)	05/82	3792-CE
	Power System Loss Reduction Study (English)	07/83	007/83
	Status Report (English)	01/84	010/84
	Industrial Energy Conservation Study (English)	03/86	054/86

EUROPE AND CENTRAL ASIA (ECA)

Bulgaria	Natural Gas Policies and Issues (English)	10/96	188/96
Central Asia and The Caucasus	Cleaner Transport Fuels in Central Asia and the Caucasus	08/01	242/01
Central and Eastern Europe	Power Sector Reform in Selected Countries	07/97	196/97
	Increasing the Efficiency of Heating Systems in Central and Eastern Europe and the Former Soviet Union (English and Russian)	08/00	234/00
	The Future of Natural Gas in Eastern Europe (English)	08/92	149/92
Kazakhstan	Natural Gas Investment Study, Volumes 1, 2 & 3	12/97	199/97
Kazakhstan & Kyrgyzstan	Opportunities for Renewable Energy Development	11/97	16855-KAZ
Poland	Energy Sector Restructuring Program Vols. I-V (English)	01/93	153/93
	Natural Gas Upstream Policy (English and Polish)	08/98	206/98
	Energy Sector Restructuring Program: Establishing the Energy Regulation Authority	10/98	208/98
Portugal	Energy Assessment (English)	04/84	4824-PO
Romania	Natural Gas Development Strategy (English)	12/96	192/96
Slovenia	Workshop on Private Participation in the Power Sector (English)	02/99	211/99
Turkey	Energy Assessment (English)	03/83	3877-TU
	Energy and the Environment: Issues and Options Paper	04/00	229/00

MIDDLE EAST AND NORTH AFRICA (MNA)

Arab Republic of Egypt	Energy Assessment (English)	10/96	189/96
	Energy Assessment (English and French)	03/84	4157-MOR
	Status Report (English and French)	01/86	048/86
Morocco	Energy Sector Institutional Development Study (English and French)	07/95	173/95
	Natural Gas Pricing Study (French)	10/98	209/98
	Gas Development Plan Phase II (French)	02/99	210/99
Syria	Energy Assessment (English)	05/86	5822-SYR
	Electric Power Efficiency Study (English)	09/88	089/88
	Energy Efficiency Improvement in the Cement Sector (English)	04/89	099/89
	Energy Efficiency Improvement in the Fertilizer Sector (English)	06/90	115/90
Tunisia	Fuel Substitution (English and French)	03/90	--
	Power Efficiency Study (English and French)	02/92	136/91
	Energy Management Strategy in the Residential and Tertiary Sectors (English)	04/92	146/92
	Renewable Energy Strategy Study, Volume I (French)	11/96	190A/96

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Tunisia	Renewable Energy Strategy Study, Volume II (French)	11/96	190B/96
Yemen	Energy Assessment (English)	12/84	4892-YAR
	Energy Investment Priorities (English)	02/87	6376-YAR
	Household Energy Strategy Study Phase I (English)	03/91	126/91

LATIN AMERICA AND THE CARIBBEAN (LAC)

LAC Regional	Regional Seminar on Electric Power System Loss Reduction in the Caribbean (English)	07/89	--
	Elimination of Lead in Gasoline in Latin America and the Caribbean (English and Spanish)	04/97	194/97
	Elimination of Lead in Gasoline in Latin America and the Caribbean - Status Report (English and Spanish)	12/97	200/97
	Harmonization of Fuels Specifications in Latin America and the Caribbean (English and Spanish)	06/98	203/98
Bolivia	Energy Assessment (English)	04/83	4213-BO
	National Energy Plan (English)	12/87	--
	La Paz Private Power Technical Assistance (English)	11/90	111/90
	Prefeasibility Evaluation Rural Electrification and Demand Assessment (English and Spanish)	04/91	129/91
	National Energy Plan (Spanish)	08/91	131/91
	Private Power Generation and Transmission (English)	01/92	137/91
	Natural Gas Distribution: Economics and Regulation (English)	03/92	125/92
	Natural Gas Sector Policies and Issues (English and Spanish)	12/93	164/93
	Household Rural Energy Strategy (English and Spanish)	01/94	162/94
	Preparation of Capitalization of the Hydrocarbon Sector	12/96	191/96
	Introducing Competition into the Electricity Supply Industry in Developing Countries: Lessons from Bolivia	08/00	233/00
	Final Report on Operational Activities Rural Energy and Energy Efficiency	08/00	235/00
	Oil Industry Training for Indigenous People: The Bolivian Experience (English and Spanish)	09/01	244/01
Brazil	Energy Efficiency & Conservation: Strategic Partnership for Energy Efficiency in Brazil (English)	01/95	170/95
	Hydro and Thermal Power Sector Study	09/97	197/97
	Rural Electrification with Renewable Energy Systems in the Northeast: A Preinvestment Study	07/00	232/00
Chile	Energy Sector Review (English)	08/88	7129-CH
Colombia	Energy Strategy Paper (English)	12/86	--
	Power Sector Restructuring (English)	11/94	169/94
	Energy Efficiency Report for the Commercial and Public Sector (English)	06/96	184/96
Costa Rica	Energy Assessment (English and Spanish)	01/84	4655-CR
	Recommended Technical Assistance Projects (English)	11/84	027/84
	Forest Residues Utilization Study (English and Spanish)	02/90	108/90
Dominican Republic	Energy Assessment (English)	05/91	8234-DO
Ecuador	Energy Assessment (Spanish)	12/85	5865-EC
	Energy Strategy Phase I (Spanish)	07/88	--
	Energy Strategy (English)	04/91	--
	Private Minihydropower Development Study (English)	11/92	--

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Ecuador	Energy Pricing Subsidies and Interfuel Substitution (English)	08/94	11798-EC
	Energy Pricing, Poverty and Social Mitigation (English)	08/94	12831-EC
Guatemala	Issues and Options in the Energy Sector (English)	09/93	12160-GU
Haiti	Energy Assessment (English and French)	06/82	3672-HA
	Status Report (English and French)	08/85	041/85
	Household Energy Strategy (English and French)	12/91	143/91
Honduras	Energy Assessment (English)	08/87	6476-HO
	Petroleum Supply Management (English)	03/91	128/91
Jamaica	Energy Assessment (English)	04/85	5466-JM
	Petroleum Procurement, Refining, and Distribution Study (English)	11/86	061/86
	Energy Efficiency Building Code Phase I (English)	03/88	--
	Energy Efficiency Standards and Labels Phase I (English)	03/88	--
	Management Information System Phase I (English)	03/88	--
	Charcoal Production Project (English)	09/88	090/88
	FIDCO Sawmill Residues Utilization Study (English)	09/88	088/88
	Energy Sector Strategy and Investment Planning Study (English)	07/92	135/92
Mexico	Improved Charcoal Production Within Forest Management for the State of Veracruz (English and Spanish)	08/91	138/91
	Energy Efficiency Management Technical Assistance to the Comision Nacional para el Ahorro de Energia (CONAE) (English)	04/96	180/96
	Energy Environment Review	05/01	241/01
Nicaragua	Modernizing the Fuelwood Sector in Managua and León	12/01	252/01
Panama	Power System Efficiency Study (English)	06/83	004/83
Paraguay	Energy Assessment (English)	10/84	5145-PA
	Recommended Technical Assistance Projects (English)	09/85	--
	Status Report (English and Spanish)	09/85	043/85
Peru	Energy Assessment (English)	01/84	4677-PE
	Status Report (English)	08/85	040/85
	Proposal for a Stove Dissemination Program in the Sierra (English and Spanish)	02/87	064/87
	Energy Strategy (English and Spanish)	12/90	--
	Study of Energy Taxation and Liberalization of the Hydrocarbons Sector (English and Spanish)	120/93	159/93
	Reform and Privatization in the Hydrocarbon Sector (English and Spanish)	07/99	216/99
	Rural Electrification	02/01	238/01
Saint Lucia	Energy Assessment (English)	09/84	5111-SLU
St. Vincent and the Grenadines	Energy Assessment (English)	09/84	5103-STV
Sub Andean	Environmental and Social Regulation of Oil and Gas Operations in Sensitive Areas of the Sub-Andean Basin (English and Spanish)	07/99	217/99
Trinidad and Tobago	Energy Assessment (English)	12/85	5930-TR

GLOBAL

	Energy End Use Efficiency: Research and Strategy (English)	11/89	--
	Women and Energy--A Resource Guide The International Network: Policies and Experience (English)	04/90	--

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Global	Guidelines for Utility Customer Management and Metering (English and Spanish)	07/91	--
	Assessment of Personal Computer Models for Energy Planning in Developing Countries (English)	10/91	--
	Long-Term Gas Contracts Principles and Applications (English)	02/93	152/93
	Comparative Behavior of Firms Under Public and Private Ownership (English)	05/93	155/93
	Development of Regional Electric Power Networks (English)	10/94	--
	Roundtable on Energy Efficiency (English)	02/95	171/95
	Assessing Pollution Abatement Policies with a Case Study of Ankara (English)	11/95	177/95
	A Synopsis of the Third Annual Roundtable on Independent Power Projects: Rhetoric and Reality (English)	08/96	187/96
	Rural Energy and Development Roundtable (English)	05/98	202/98
	A Synopsis of the Second Roundtable on Energy Efficiency: Institutional and Financial Delivery Mechanisms (English)	09/98	207/98
	The Effect of a Shadow Price on Carbon Emission in the Energy Portfolio of the World Bank: A Carbon Backcasting Exercise (English)	02/99	212/99
	Increasing the Efficiency of Gas Distribution Phase 1: Case Studies and Thematic Data Sheets	07/99	218/99
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	Global Lighting Services for the Poor Phase II: Text Marketing of Small "Solar" Batteries for Rural Electrification Purposes	08/99	220/99
	A Review of the Renewable Energy Activities of the UNDP/ World Bank Energy Sector Management Assistance Programme 1993 to 1998	11/99	223/99
	Energy, Transportation and Environment: Policy Options for Environmental Improvement	12/99	224/99
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	Reducing the Cost of Grid Extension for Rural Electrification	02/00	227/00
	Undeveloped Oil and Gas Fields in the Industrializing World	02/01	239/01
	Best Practice Manual: Promoting Decentralized Electrification Investment	10/01	248/01
	Peri-Urban Electricity Consumers—A Forgotten but Important Group: What Can We Do to Electrify Them?	10/01	249/01
	Village Power 2000: Empowering People and Transforming Markets	10/01	251/01
	Private Financing for Community Infrastructure	05/02	256/02

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