PARTNERSHIP FOR CLEAN INDOOR AIR

Household Energy, Indoor Air Pollution and Health: Overview of Experiences and Lessons in India

Prepared by

WINROCK INTERNATIONAL
Putting Ideas to Work

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Coordination and Implementation Support for the Partnership for Clean Indoor Air

The Partnership for Clean Indoor Air was launched at the World Summit on Sustainable Development in Johannesburg in September 2002 to address the increased environmental health risk faced by more than two billion people who burn traditional biomass fuels indoors for cooking and heating. The Partnership is led by the U.S. Environmental Protection Agency with support from the U.S. Agency for International Development. The mission of the Partnership is to improve health, livelihood and quality of life by reducing exposure to air pollution, primarily among women and children, from household energy use. For more information please visit www.PCIAonline.org

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ABBREVIATIONS AND ACRONYMS

AFPRO	Action for Food Production
AIDS	acquired immune deficiency syndrome
AKRSP	Aga Khan Rural Support Program
ARI	acute respiratory infections
ARTI	Appropriate Rural Technology Institute
CDM	clean development Mechanisms
CIDA	Canadian International Development Agency
COPD	chronic obstructive pulmonary disease
CSSM	Child Survival and Safe Motherhood Program
DALYs	disability adjusted life years
DPT	diphtheria, pertussis and tetanus
EPA	Environmental Protection Agency
ESMAP	Energy Sector Management Assistance Program
GDP	gross domestic product
GV	Gram Vikas
HIV	human immunodeficiency virus
IAP	indoor air pollution
IMCI	integrated management of childhood illnesses
LPG	liquefied petroleum gas
MNES	Ministry of Non-conventional Energy Sources
MOPNG	Ministry of Petroleum and Natural Gas
MWT	mobile women's teams
NCAER	National Council of Applied Economic Research
NGO	non-governmental organization
NPBD	National Project on Biogas Development
NPIC	National Program on Improved Chulhas
ORS	oral rehydration solution
PM	particulate matter
PRAD	Planning Research and Action Division
RCGs	Regional Consultative Groups
RHEP	Rural Health and Environment Program
SEWA	Self-Employed Women's Association
TB	tuberculosis
TBU	Technical Back-up Unit
TERI	The Energy Research Institute
TKW	Turn Key Worker
UIP	Universal Immunization Program
UNDP	United Nations Development Program
UNEP	United Nations Environment Program
UNICEF	United Nations Children's Fund
WHO	World Health Organization

I. REPORT HIGHLIGHTS

Overview of Household Energy and Health in India

- India has one of the highest rates of maternal and child mortalities. Acute Respiratory Infections (ARI) is the largest single disease category in India and the Indian portion of ARI accounts for 2.5% of the global burden of ill health - about 400,000 to 500,000 deaths on a national scale annually.
- Studies indicate that exposure to biomass smoke or indoor air pollution (IAP) is associated with chronic bronchitis, tuberculosis, cataracts and ARI.
- Over 70% of the country's population reside in rural areas and predominantly use biomass fuels on traditional stoves. Cooking accounts for 55-97% of all household energy used.
- In states like rural Rajasthan, women spend as much as 50 hours every month in fuelwood collection.

Key Actors and Stakeholders in the Field of Household Energy and Health in India

- The Ministry of Non-Conventional Energy Sources has initiated renewable energy programs in India including the national stove and biogas programs. Management of the stove program has been handed over to individual state agencies.
- Ministry of Petroleum and Natural Gas (MOPNG) is responsible for the allocation and use of all petroleum products including kerosene and LPG.
- The Department of Women and Child Development launched the Integrated Child Development Services to ensure doorstep delivery of health services to address childhood diseases like ARI.
- The United Nations Children's Fund's main priority in India is to reduce infant mortality rates and in 1992 the organization in collaboration with the World Health Organization launched the Integrated Management of Childhood Illnesses (IMCI) program.
- The World Bank launched the Clean Air Initiative (CAI) Asia, part of a global effort to improve the air quality in cities around the world. While primarily focusing on outdoor air quality, this initiative is addressing indoor air pollution in India and held a regional workshop in Delhi in May 2002, which brought together policy makers, scientists, and NGOs.
- The Appropriate Rural Technology Institute (ARTI) was the main technical agency for the state of Maharashtra under the government's National Program on Improved Chulhas (NPIC). The NGO is also a recent Shell Foundation grantee. In addition to ARTI, there are 15 additional agencies, which implemented the stove program in other states.

Key Household Energy and Health Programs in India

- The National Program on Improved Chulhas (NPIC) was launched in 1983 and by 2000 had disseminated about 32 million improved stoves nationwide. Primary objectives of the Program included reduction in demand for fuelwood and removal of smoke from kitchens.

- The National Project on Biogas Development (NPBD) started in 1981 and aimed to provide clean energy and eliminate smoke from cooking environments. As of March 2003, over 350,000 family sized biogas plants have been constructed throughout the country.
- The Deepam Scheme, launched by the State government of Andhra Pradesh in 1999, aimed to promote LPG use by subsidizing initial connection costs. As of March 2002, over 1.5 million LPG connections have been installed through the Scheme.
- The Government has a Kerosene scheme through which it provides large subsidies for the fuel. State owned oil companies handle the subsidized fuel. The fuel is distributed through fair price shops. Allocation of fuel varies from state to state and urban areas in general receive higher subsidies than rural areas. Families with ration cards can purchase the subsidized fuel.

Lessons Learned

- Both stove and biogas programs were heavily subsidized and employed a target oriented dissemination approach. This resulted in lack of incentives to adopt the products. The commercialization approach was successful in states such as Haryana, which experienced fuelwood shortages and households usually bought stoves. The LPG Scheme was not heavily subsidized, however, poor infrastructure affected distribution. In states other than Maharashtra, the Government provides subsidized LPG, which favors the higher income groups who have ready access to the fuel. Although, kerosene subsidy has allowed lower income households to gain better access to the fuel, price control has prevented competition needed to lower prices and make the fuel accessible to the population most in need of cleaner fuels.
- The stove and biogas programs had very strong technical backup components. However, poor communication between policy makers, field staff and users, and inadequate training on construction and maintenance affected adoption rates. There was considerable success in areas where all aspects of dissemination and implementation were addressed.
- Impacts of these programs on IAP reduction could not be assessed since IAP levels were not monitored. Exposure monitoring was conducted under the LPG scheme and provided important insights which included the need to substantially increase LPG use in order to bring about a significant decrease in pollutant levels.
- Interaction with the main users was minimal in both biogas and stove programs. However in states like Haryana, women’s groups were involved during stove design and dissemination. Issues like cultural and fuel management practices and adoption of behavior change communication strategies emerged as key aspects that require greater attention.

II. INTRODUCTION

Figure 1 Map of India, with its Neighboring Countries

India is one of the key countries demonstrating high potential for success of revised and innovative approaches to household energy and health. One of the ten fastest growing developing countries, India has significant gender disparity in the burden of work measure: 457 minutes per day for women and 391 minutes per day for men. Women's share of work for non-market activities is far greater than that of men; 65% of a woman's time is devoted to these activities while for men it is only 18% of total time[1]. Disparities are also evident in education with literacy rates of 46.4% for women and 69% for men. India has one of the highest rates of maternal and child mortalities. Acute respiratory infections (ARI) are one of the main causes of death for children under-five. Acute respiratory infections in India are the largest single disease category in the country, accounting for 2.5% of the global burden of ill health. In recent years there have been several studies highlighting the association between indoor air pollution from burning biomass fuels on unvented, inefficient stoves, and various diseases including ARI. Over 70% of the country's population reside in rural areas and predominantly use biomass fuels in traditional stoves[2].

Since the early eighties the Government of India has initiated several household energy programs (focusing on improved stoves, biogas plants, kerosene and LPG supplies), which were aimed at reducing the dependence on biomass fuels and removing smoke from kitchens. Although these programs had varying levels of success, there now appears to exist technical expertise (trained

[1] For market activities however it is 35% for women and 92% for men.

[2] Open mouthed stove, usually made with mud or clay with an opening for fuels. Does not have chimneys or other venting mechanisms.

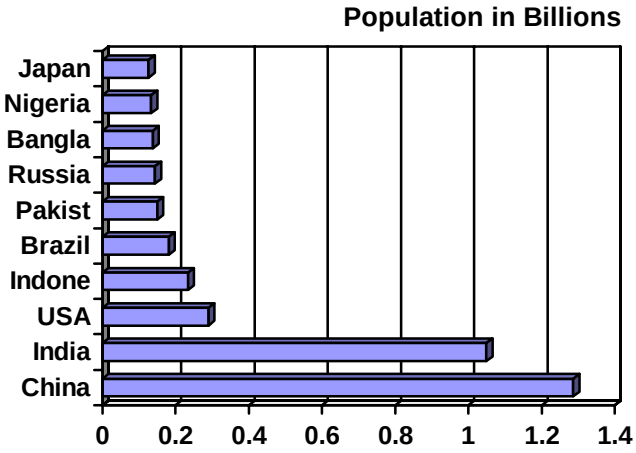
workers, technical units) at the grass-roots levels and extensive infrastructure (executing agencies) for implementing similar projects. The lessons learned from these experiences can be the key to implementing successful household energy and health interventions in the future. Coupled with this is the country's widespread health system with its networks of women's groups, village centers and doorstep health services provided by health workers. In addition, experience with existing behavior change interventions in the health sector can be harnessed to focus on health issues arising from the use of household energy. This presents an ideal opportunity for combining household energy use and health issues and addressing key areas of concern like indoor air pollution and intervention measures.

The following sections describe the health and household energy scenarios in India and discuss the potential for intervention measures.

III. OVERVIEW OF HEALTH IN INDIA

India is the second most populous country in the world with over a billion (1033.4 million) inhabitants. Life expectancy is at 63.3 years[3] and 34.7% of the population lives on US$ 1 or less per day. There are an estimated 400 million children between the ages of 0 and 18. However, the country faces many challenges. India's infant mortality rate at 67 deaths for every 1000 live births is still one of the highest in the world; under 5 mortality is 93 deaths for every 1000 live births[4]. In addition, the maternal mortality ratio[5] is at 5706 indicating that maternal and child health is still one of the key areas that need immediate attention.

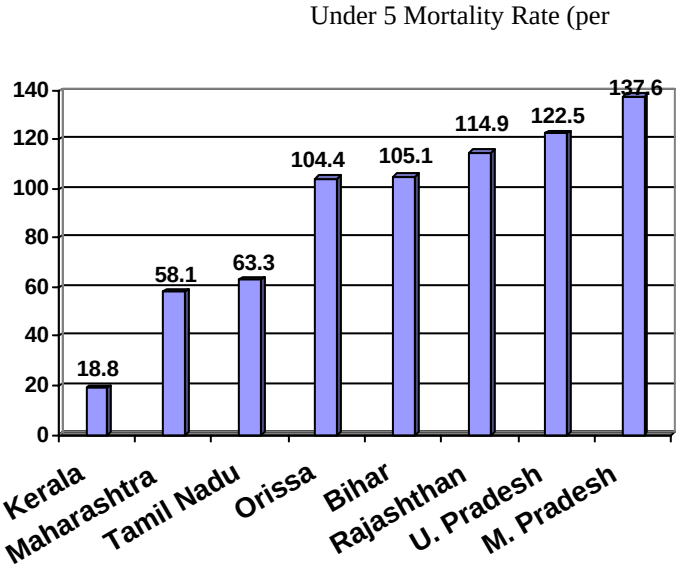
Figure 2 World's Most Populous Countries



Source: International Data Base, U.S. Census Bureau. January 27 2004. <http://www.census.gov/cgi-bin/ipc/idbrank.pl>

[3] 64 years for women and 62.8 years for men.
[4] Compared to 8 per 1000 in the US and 40 per 1000 in China. Population, Health and Human Well Being, World Resources Institute, October 16. 2003 <http://earthtrends.wri.org/pdf_library/data_tables/pop1_2003.pdf>
[5] The number of women who die as a result of childbearing, during the pregnancy or within 42 days of delivery or termination of pregnancy in one year, per 100 000 live births during that year.
[6] Compared to 12 for the United States and 95 for China (Monitoring ICPD Goals – Selected Indicators, UNFPA, October 16. 2003 <http://www.unfpa.org/swp/1996/pdf/icpgol96.pdf>

Figure 3 Under 5 Infant Mortality Rate in Selected Indian States



Source: National Family Health Survey, Ministry of Health and Family Welfare

Acute respiratory infections (ARI) represent one of the leading causes of under-5 mortality in the country. As seen in Fig. 3, these mortality rates vary greatly by state. Whereas Kerala has one of the lowest rates in the country, Madhya Pradesh has one of the highest with almost 138 deaths per thousand live births. Refer to Table A1 in Annex A for further information on health differentials in the country. To date there has been little progress in improving the care seeking behavior[7] for the diseases, which can substantially reduce the number of deaths. According to India's Demographic and Health Survey 2000, only 64% of the children under 5 with ARI were taken to a health provider. About 38% of the children aged 12-24 months were fully immunized received BCG (Mycobacterium bovis bacille Calmette-Guerin), 3 doses of DPT (Diphtheria, Pertussis and Tetanus), Polio and Measles vaccine[8]. There were also some differences by gender and region; about 37% of the female children were fully immunized versus nearly 39% of male children. Almost 52% of the children living in urban areas were fully immunized whereas the figure is only about 34% for children in rural areas. Similar disparities are also evident for consulting a health provider for children with ARI; in South Asia 70% of the children in urban areas and 55% in rural areas were taken to a health provider[9]. Only 28% of India's population lives in urban areas. In addition to ARI there are other competing issues like diarrhea and HIV/AIDS[10] that are also priority areas for intervention. Unfortunately, public expenditure on health accounts for only 0.9% of the GDP and there are about 48 physicians for every 100,000 persons.

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[7] Detecting early symptoms of ARI, taking children to an appropriate health care provider and proper administration of antibiotics.

[8] "Multiple Indicator Survey 2000," Department of Women and Child Development and UNICEF, November 2001, Diseases like Measles, Pertussis and Diphtheria are directly or indirectly responsible for 15-25% of all deaths related to ARI therefore, vaccinating against these diseases also protects against possible cases of ARI.

[9] 'Acute Respiratory Infection (ARI),' UNICEF Statistics, October 3, 2003
< http://www.childinfo.org/eddb/ARI/unfinished.htm>

[10] Number of people (0 – 49 yrs) living with HIV/AIDS: 3,970,000, Children: 170,000 [end 2001]

This is compared to 5.8% of GDP in the United States for health expenditures and 3.1% in China[11]. The percentage of central government allocation to health between 1992 – 2001 for China and United States was 0% and 21% respectively whereas for India it was 2%[12].

In order to get a full understanding of the association between household energy, indoor air pollution (IAP) and health it is important to look at the types of health interventions of the country. The following section will provide brief descriptions of programs aimed at preventing acute respiratory infections (ARI). In addition to pneumonia, diseases like measles, pertussis and diphtheria are directly or indirectly responsible for 15-25% of all deaths related to ARI. Therefore, both pneumonia control and immunization programs are described below. Other important maternal and child health programs are described in Annex B.

Acute Respiratory Infection (Pneumonia) Control

The program started in 1989 and was implemented in six states on a pilot basis. In 1992 it was implemented in all districts as part of the Child Survival and Safe Motherhood Program (CSSM). The objective of this project is to strengthen the family welfare and health delivery systems in order to provide better services. At present it is a part of the Reproductive and Child Health Program under the Department of Family Welfare. ARI accounts for about 30% of under-five deaths in the country. Health workers have received training on ARI management. Communication messages largely focus on recognizing early symptoms and timely referrals. The messages are principally channeled through mothers' meetings, interpersonal communication and involvement of other sectors such as NGOs.

Universal Immunization Program (UIP)

The UIP started in 1985 under the auspices of the Department of Health and became operational in all districts of the country in 1989. The program later merged with the Child Health and Safe Motherhood program in 1992 and Reproductive and Child Health program of the Ministry of Family Welfare in 1997. Under the UIP, vaccines are given to infants and pregnant women for preventing childhood TB, diptheria, pertussis, poliolmyelitis, measles and neo-natal tetanus. The program has achieved high coverage rates. The Urban Measles Campaign which started in 1998 with assistance from UNICEF aims to cover all unprotected children till the age of 3 years with a single dose of measles vaccine.

Primary Heath Care Services for Scheduled Castes and Scheduled Tribes

Populations belonging to scheduled castes and tribes constitute a little over 24%[13] of the population of the country. It can be assumed that these communities are more susceptible to poor health outcomes and are more disadvantaged[14] than the rest of the population. A greater number of primary health centers and sub-centers have been established for these populations. In addition, the States are implementing the National Malaria Eradication Program. The Central government assists with spraying insecticide and anti-malaria drugs among other measures. Predominantly tribal states are also under the Enhanced Malaria Control Project with support from the World Bank.

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[11] Monitoring ICPD Goals – Selected Indicators, UNFPA, January 27 2004. <http://www.unfpa.org/swp/2003/presskit/pdf/indicators_eng.pdf>

[12] United Nations Children's Fund <http://www.unicef.org/infobycountry/index.html>

[13] India at a Glance: Scheduled Castes and Tribes Population, Census of India 1991, October 15, 2003 <http://www.censusindia.net/scst.html>

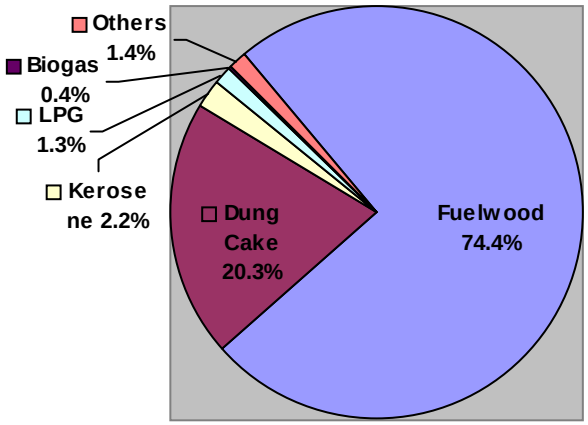
[14] Due to their social standing as is the case for the scheduled castes (also known as dalits or untouchables) or because they live in remote areas like communities belonging to scheduled tribes.

It may be important to have special focus on these communities while designing household energy and health interventions, due to their high degree of marginalization and the resulting government attention to public health services in these areas. Further information will be needed to assess their current situation with respect to household energy in order to formulate relevant recommendations.

IV. HOUSEHOLD ENERGY, INDOOR AIR POLLUTION AND HEALTH IN INDIA

In India where over 70% of the population live in rural areas, cooking is traditionally carried out on unvented stoves with women and children experiencing the highest exposures to harmful levels of particulates, carbon monoxide, nitrogen oxides and other products of inefficient biomass combustion. Traditional fuels (firewood, crop residue, dry leaves, dung, etc.) constitute about 90% of the total energy used in rural households. According to the National Institute of Urban Affaires, in 1991 there were about 46 million people living in the urban slums of India and projected figures for 2001 showed just under 62 million. In 1993, nearly 32% of the country's urban population was living below the poverty line. In most urban slums, access to traditional fuels is even more limited than rural areas and households that cannot afford to purchase cleaner fuels (kerosene, LPG, electricity) are forced to use various residual fuels such as scrap paper, plastics, shreds of cloth etc, which can have far worse health impacts.

Figure 4 Fuel Sources for Cooking (percent)



Source: NCAER 1996

Studies on Household Energy, Indoor Air Pollution, and Health

In the last few years, there have been several studies that have focused on the health impacts of IAP and its association with household energy use in India. These indicate that exposure to biomass smoke is associated with chronic bronchitis[15], tuberculosis[16], cataracts[17] and acute respiratory

[15] Behera D, Jindal SK, Malhotra HS, "Ventilatory function in nonsmoking rural Indian women using different cooking fuels," Respiration, 1994(61):89-92.
[16] Mishra VK et al., "Biomass cooking fuels and prevalence of tuberculosis in India," International Journal of Infectious Diseases, 1999(3): 119-129
[17] Mishra VK, Retherford RD, Smith KR, "Biomass cooking fuels and prevalence of blindness in India," Journal of Environmental Medicine(in press).

infections (ARI)[18]. The Smith study[19] of the national burden of disease is probably one of the most well-known and comprehensive publications of its kind. Available data from the study indicate that the distribution of PM_{10} 24 hour concentrations measured in Indian households using solid fuel range well over 2000 µg/m^3. This is in comparison to 150µg/m^3 level set by the EPA for 24-hour concentrations of PM_{10}. During the cooking period this level is much higher and in densely populated communities, high emissions from solid fuels can result in elevated 'neighborhood' pollution[20]. It is estimated that acute respiratory infections (ARI), diseases which have strong correlation with exposure to indoor air pollution, account for about one-ninth of the national disease burden. The Indian ARI is also the largest single disease category in the world and accounts for 2.5% of the global burden of ill health. Ill health from indoor air pollution appears to comprise a substantial portion (4% - 6%) of the national disease burden of the country. This is equivalent to 6.3 – 9.2% of the burden for women and children under 5 (making up 44% of India's population). Adverse pregnancy outcomes, also associated with exposure to indoor air pollution, constitute 7.5% of the national disease burden and as much as 20% of the disease burden for children under five. In addition, diseases like Chronic Obstructive Pulmonary Disease (COPD), TB and lung cancer constitute 0.9%, 0.1% and 0.5% of the national burdens of disease respectively. The disease burden of unhealthy levels of indoor air, 4% - 6%, is third only to dirty water (10%) and malnutrition (22%). This amounts to annual 'best estimates' of about 400,000 to 500,000 deaths and 1.8 – 2.0 billion Disability Adjusted Life Years (DALYs) of women and children under five on a national scale from exposure to indoor air pollution.

V. HOUSEHOLD ENERGY IN INDIA

Although the energy use pattern in rural India is changing, traditional fuels, like fuelwood, crop residue and cow dung still constitute the main source of household cooking energy. Such fuels in fact account for about 90% of the total energy use in rural households. The figure[21] below gives a breakdown of a typical fuel mix in cooking. It is evident that fuelwood still constitutes a large proportion (75%) of the fuel used, followed by dung cakes. The "other" category refers to residual fuels like dry leaves, crop residues and straw.

Residential energy is primarily used for cooking, water heating, space heating, cooling, preparing cattle feed and lighting. Refer to Table C1 in Annex C for a breakdown of energy use in India, by sector. Cooking and heating appear to be the essential household energy activities in rural areas. According to an ESMAP[22] study[23], cooking accounts for 55-97% of all household energy used. Some

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[18] Smith K et al, "Indoor Air Pollution in developing countries and acute respiratory infections in children," Thorax, 2000(55):518-532 and Smith KR, "The National Burden of Disease from Indoor Air Pollution in India," Proceedings of the National Academy of Sciences, November 21, 2000:97(24).

[19] Kirk, R, Smith, "*National burden of Disease in India from Indoor Air Pollution*," Proceedings of the National Academy of Sciences, November 21, 2000:97(24).

[20] Kirk, R, Smith, "*National burden of Disease in India from Indoor Air Pollution*," Proceedings of the National Academy of Sciences, November 21, 2000:97(24).

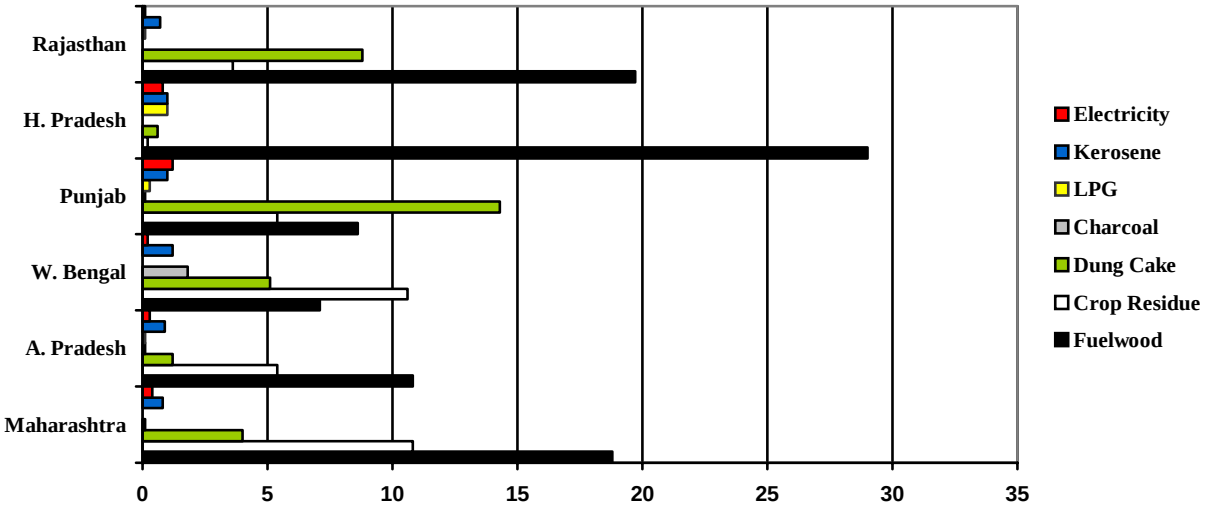
[21] Venkata R. Putti, "As if Institutions Matter: An Assessment of Renewable Energy Technologies in Rural India," Technology and Development Group, University of Twente, The Netherlands, 1998.

[22] The Energy Sector Management Assistance Program (ESMAP) was established in 1983 by the World Bank and the UNDP in response to the global energy crisis. This is a global technical assistance program which builds consensus and provides policy advise on sustainable energy development to governments of developing countries and economies in transition.

[23] Energy Strategies for Rural India: Evidence from Six States, Joint UNDP/Word Bank Energy Sector Management Assistance Program (ESM AP), August 2002.

activities also overlap. For example, water heating and space heating may be an extension of cooking activities. Comparatively cleaner fuels like kerosene are normally used to ignite the fire for cooking. LPG consumption in rural areas remains low and is limited to high-income households. However, LPG use is higher in the state of Himachal Pradesh where the fuel has been subsidized to preserve the forests. In addition to high costs, limited LPG supply is one of the main constraints for low usage of the fuel. In India, most of the LPG is imported and therefore its supply depends on the transport and distribution infrastructures. During the year 1999 – 2000, state owned oil companies, which highly subsidize fuel prices, had control over almost 95% of the LPG market[24]. The state LPG dealers concentrate more on urban markets and cater primarily to higher income households. Since all LPG distribution has been traditionally controlled by state agencies, there is no publicly available information on growth rates for LPG markets. The following figure depicts the per capita use of selected fuels in six Indian states. Refer to Table C2 in Annex C for further information on fuel use.

Figure 5 Energy Use in Six Indian States by Selected Fuel Type (KgOE per Person per Month)



Source: Energy Strategies for Rural India: Evidence from Six States, UNDP/ World Bank Energy Sector Management Assistance Program (ESMAP), August 2002.

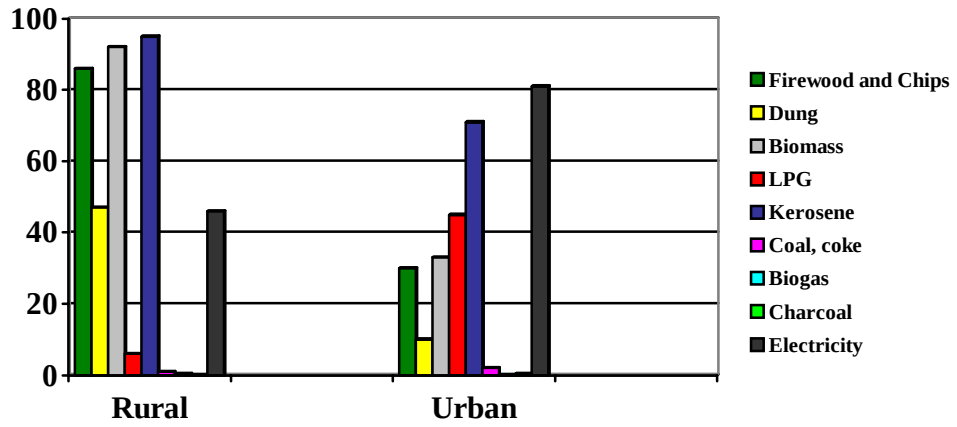
Among traditional fuels, fuelwood is the fuel of choice but the share of fuelwood, crop residue and dung in the fuel mixture depends largely on their availability and costs. As seen in the following table, whereas fuelwood is widely used in Himachal Pradesh and Maharashtra (29% and 18.8%), dung use is more prevalent in Rajasthan (8.8%) where animal husbandry is an important occupation. In many instances, households will opt for easily accessible and available fuel, like crop residues, rather than a cleaner burning fuel like wood. However, between 1980 and 1996, there has been a shift in the type of energy used. In states like Andhra Pradesh, Punjab and West Bengal, the percentage of households using fuelwood declined due to fuelwood shortages, commercialization of fuelwood and greater availability of other fuels. Whereas in Andhra Pradesh households switched

[24] "Access of the Poor to Clean Household Fuels in India, Joint UNDP/Word Bank Energy Sector Management Assistance Program (ESMAP), July 2003.
< http://wbln0018.worldbank.org/esmap/site.nsf/files/263-03+India.pdf/$FILE/263-03+India.pdf>

from using fuelwood to straw, in Punjab more households were using dung, kerosene and LPG since the state has traditionally very little natural forest cover (less than 3%).

Cooking accounts for 62% of the household energy consumption in urban India[25]. With increasing income, urban households tend to use energy for other purposes like water heating, space heating and cooling. Urban households also have greater access to cleaner fuels like kerosene and LPG than rural areas. The following graphs provide a breakdown of the percentage of households by fuel type in rural and urban India.

Figure 6 Uptake of Different Energy Sources (percentage of all households), 1999-2000



Source: Access of the Poor to Clean Household Fuels in India, UNDP/ World Bank Energy Sector Management Assistance Program (ESMAP), July 2003.

The Government of India has a public distribution system though which customers with ration cards can purchase kerosene at a highly subsidized price. Urban dwellers are allocated a greater amount of kerosene (15 liters/month) compared to their rural counterparts (4 liters/month). Rural households usually start to use kerosene with a rise in incomes. LPG is the preferred fuel in urban India. In June of 2003 it was announced that the LPG and kerosene subsidies will be reduced in three years and completely eliminated by 2006. In recent years the LPG market has opened up and private retailers are competing along with government-controlled suppliers. In addition, private businesses have also been allowed to produce LPG cylinders, which have been in short supply. Please refer to Tables C3 and C4 in Annex C for fuel use in urban households.

Subsidization of cleaner fuels like kerosene and LPG has been a contentious issue compounded by the lack of a universally accepted subsidy mechanism. A liberalized and competitive market for such fuels will, in the long run, lower costs and make them accessible to more consumers. In addition, it is widely accepted that neither kerosene nor LPG will be the predominant fuel for very poor households due to the availability of 'free' biomass fuels. Rural and urban households also have different criteria for fuel switching and factors like convenience, availability, awareness and social values play significant roles in these decisions.

[25] Thierry Lefevre, Todoc, J. L and Timilsina, G. R., "The Role of Wood Energy in Asia," Asian Institute of Technology, Bangkok, Thailand, September 25, 2003
< http://www.fao.org/docrep/w7519e/w7519e00.htm>

Traditional fuels, the most commonly used household fuels, however, have deeper implications. The ESMAP study states that 75% of the households surveyed collected fuelwood by the head or shoulder load. Women and children are susceptible to adverse health impacts from carrying heavy fuel loads on their heads, necks and backs. Traditional gender roles for girls in South Asia restrict them to household chores (including fuel and water collection), which have adverse impacts on their education[26]. Lower income groups spend more time collecting fuelwood since they are unable to purchase fuelwood or use commercial fuels. Although fuelwood collection is predominantly carried out by women and children, it was found that the men get involved once the task requires traveling long distances from home, especially if a bullock[27] cart is available to transport the fuel. Another study[28] conducted in rural Rajasthan found that women walk as much as 2.5 km per day to collect fuel. This amounts to about 16 trips each month. At 3 hours per trip the statistics becomes quite significant: 50 hours every month in fuelwood collection. Refer to Tables C5 and C6 in Annex C for more information on the time and effort involved in fuelwood collection.

Although there is no direct correlation between deforestation and rural energy use[29], high population growth rates have increased the demand for agricultural, industrial and commercial lands. There is however some evidence that fuelwood pressure further depletes an already degraded land. In addition small cities and towns contribute to this pressure by acting as markets for fuelwood (usually brought in head loads by local villagers).

The Government of India has initiated several household energy interventions primarily to reduce the dependence on biomass fuels. These include improved chulhas (cookstoves), biogas plants/burners, LPG connections and solar cookers. However, such alternative energy technologies have faced significant challenges in India. Improved stoves and biogas burners are more familiar due to their relative successes. However, solar cookers have not been widely accepted. Refer to Table C7 in Annex C for information on the percentage of households that own rural energy devices. These interventions are further discussed under “Household Energy Programs and Projects in India”.

VI. KEY ACTORS AND STAKEHOLDERS IN HOUSEHOLD ENERGY AND HEALTH IN INDIA

There are various actors in the health and household energy sectors in India. These include governmental agencies, NGOs, research institutes, multinational organizations, donor agencies etc. Within each sector these parties work in a collaborative effort to address urban and rural health and energy issues of the country. For example, international organizations like UNICEF and the WHO regularly collaborate with the Ministry of Health and Family Welfare and other governmental bodies to develop and implement health related programs throughout the country. The Urban Measles Campaign discussed earlier is such an example. Due to the large rural population of the country, rural energy is an important issue in the household energy sector and there have been several large-scale programs to provide increased access to cleaner sources of energy. Until recently, household energy

[26] Girl’s Education, Unicef, October 16.2003
< http://www.unicef.org/girlseducation/index.html>
[27] Cart pulled by buffalo(es)
[28] Laxmi, V., et al., “Household Energy, Women’s Hardship and Health Impacts in Rural Rajasthan, India: Need for Sustainable Energy Solutions,” Energy for Sustainable Development, March 2003:6(1).
[29] Impact of Rural Energy on Society and Environment, Human Development Report 2003, United Nations Development Program < http://www.undp.org.in/programme/rrlenrgy/rengimpt.htm>

and health issues have not been addressed collectively and this is evident in the lack of joint household energy and health programs in the country.

Possible interventions addressing household energy and health issues would have to take into account the roles played by these entities and opportunities for synergy. The following provides brief descriptions of some of the leading organizations that are working in the health and household energy sectors in India. Refer to Annex E for contact information of these organizations.

Government

Ministry of Health and Family Welfare

The Ministry is the Government's leading agency that deals with health issues of the country. There are three departments under the Ministry: Department of Health, Department of Indian Systems of Medicine and Homeopathy, and the Department of Family Welfare. The Department of Health primarily deals with maternal and child health issues and hosts several programs in conjunction with donor agencies and multilateral organizations. The Department's annual budget (2001-2002) for media and public health amounted to Rs l450.00 Crores[30] (about US$ 33.3. million)[31]

Department of Women and Child Development

The Department was established in 1985 under the Ministry of Human Resources Development in order to provide a more holistic approach to women and child development. The division formulates plans, policies and programs for both government and non-governmental organizations working in the area. The country's Integrated Child Development Services was launched in 1975 under this Department in order to provide a package of services consisting of supplementary nutrition, immunization, health check ups, referral services and pre-school non-formal education. As part of this scheme thousands of "Anganwadi" centers have been set up around the country. These centers are community centers that provide the package of services listed earlier. Anganwadi workers, local women who are given special training, deliver the services mentioned and act as community liaisons between health care seekers and providers.

Ministry of Non-Conventional Energy Sources (MNES)

India is one of the few countries in the world to host a separate ministry for non-conventional energy sources. Non-conventional energy basically includes all types of renewable energies. The Ministry has implemented several renewable energy programs, notably the National Program on Improved Chulhas (NPIC) as discussed below and the National Program on Biogas Development (NPBD). In addition the Ministry has done considerable work in the solar (photovoltaic) and hydro sectors and supports research and development efforts in the area of renewable energy with close involvement with the industrial and the academic groups of the country.

Ministry of Petroleum and Natural Gas (MOPNG)

The Ministry is responsible for the exploration and exploitation of petroleum resources including natural gas. Until early 2002, the Ministry was responsible for all uses and regulations related to

[30] 1 Crore = Rs. 10 Million (US$ 1 = Rs. 43.65)
[31] Performance Budget 2001-2002, Ministry of Health and Family Welfare <http://mohfw.nic.in/reports/Performance%20Budget%20%202001-02%20.pdf/CHAPTER1.pdf >

these products. However, the kerosene and LPG markets are undergoing deregulation and the regulatory functions are being handed over to an external regulator.

Ministry of Environment and Forests

The Ministry of Environment and Forests is the Government of India's nodal agency for planning, promotion coordination and implementation of all environmental and forestry programs. The Ministry also serves as the main agency for the United Nation's Environment Program (UNEP) in India. Main activities of the agency include: conservation of flora and fauna, pollution prevention and control and the afforestation and protection of degraded areas.

The Ministry has incorporated several gender sensitive programs in its policy framework. Although the Ministry has not played a visible role in any of the country's household energy programs, there are several programs which address women's participation in forestry resources management and this might have important implications for future household energy programs where women's access to cooking fuel is a key concern. One such initiative is the Joint Forestry Management Program, which is being implemented in 15 states across the country. Under this program, women are encouraged to participate in the Joint Forest Management Committees, grassroots level institutions for conservation, protection and management of degraded forests.

In order to regenerate and protect degraded areas, the Ministry has set up Forest Development Agencies, which will act as a financial mechanism and a coordinating body for promoting the development of the Joint Forest Management Program. This is a relatively new initiative and to date, 270 such agencies have been formed. The major thrust of this initiative is aimed at promoting 'micro-planning' for afforestation to meet the fuelwood and fodder needs of the population.

Ministry of Rural Development

The Ministry was established in 1974 with the aim of effecting change in rural areas by implementing a wide array of programs aimed at poverty alleviation, employment generation, infrastructure development and social security. Not surprisingly, many of the Government's energy related activities particularly the stove and biogas programs were implemented by the Ministry at the village level. The poverty alleviation programs paid special attention to women's empowerment issues. The Ministry consists of three departments, namely: the Department of Rural Development; the Department of Land Resources; and the Department of Drinking Water Supply.

Planning Commission

The Planning Commission is the central agency for formulating and coordinating long term plans for various sectors of the government. Therefore, the Commission's involvement is crucial in the formulation of future household energy programs that attempt to holistically approach the issue. Although the agency has not been directly involved in any household energy/indoor air pollution initiatives, it oversees the plan for the country's forestry and energy resources and in recent years has expressed interest in the link between household energy and health by collaborating on a regional workshop on energy, indoor air pollution and health. Details on the workshop are below.

Non – Governmental Organizations (NGOs)

There are several NGOs working in the health and household energy sectors in India. Some of these are discussed below. This is not a comprehensive list and it is provided to give some insight into the various actors and the activities they are involved in.

Gram Vikas

Gram Vikas is a voluntary organization working in partnership with indigenous people and other poor and marginalized communities predominantly in Orissa, India. The organization's Rural Health and Environment Program initially started in 1999 with the aim of improving the health of the rural communities through construction of sanitary toilets. The initiative eventually developed into a model for development where project participants engaged in various other activities including, housing, community infrastructure, education, livelihood programs and women's empowerment. Program staffs ensure extensive participation of both men and women during project design and implementation phases. Participants pay a one-time fee of Rs. 1000 to a corpus fund and also contribute local material and unskilled labor. Demonstration projects in the area convince villagers to request sanitation facilities. To date, the program has reached 105 villages with a total population of over 48,000 inhabitants[32]. Gram Vikas has also implemented a very successful biogas program in the state. This is described in further detail under the section titled 'Key Actors in Household Energy'.

Appropriate Rural Technology Institute (ARTI)

ARTI was established in 1996 to act as a tool for sustainable rural development through the application of scientific and technological knowledge[33]. The organization has been involved in various rural development activities including low cost tissue culture for growing plantlets (to be used as agriculturally useful planting material), using seawater for irrigation and low cost water tanks. Most notably, ARTI was the government designated technical backup unit for the state of Maharashtra under the National Program on Improved Chulhas (NPIC). Please refer to Table D2 in Annex D for a complete listing of all technical backup units. ARTI piloted a commercial approach to disseminating stoves and gave extensive support to potters and self-employed workers for this purpose. More information is provided in the following section reviewing household energy programs and projects. The organization has recently (December 2002) received a grant from the Shell Foundation to commercialize improved biomass fuels and cooking devices in the state of Maharashtra in India[34].

The Development Alternatives Group

The Development Alternatives Group is another non-profit organization with a long history of experience in rural energy issues of the country. Like ARTI the organization is a recent (December 2002) Shell Foundation award grantee and is implementing the 'Energy Services for Village Households and Livelihood Enterprises in Bundelkhand' project[35]. In collaboration with about 200 self help groups, the project will design and implement services for household cooking and lighting.

Energy Research Institute (TERI)

TERI was established in 1972 and is extensively involved in conducting applied research on the subject of household energy among other issues of energy, environment and sustainable development. The institute contributes to local and national energy strategies and also plays an active

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[32] Rural Health and Environment Program, Gram Vikas <http://www.gramvikas.org/programme.html>
[33] Appropriate Rural Technology Institute (ARTI), September 25. 20003
< http://www.littlehut.org/project1/profile.asp>
[34] Project Report, Shell Foundation, October 16. 2003
<http://www.shellfoundation.org/sf/projects/20888.html>
[35] Project Portfolio, Shell Foundation, October 16. 2003
< http://www.shellfoundation.org/breatheeasy/projects.html>

role in addressing global issues like climate change. In recent years there has been an increased focus on household energy and health issues, mainly indoor air pollution from burning biomass fuels. The institute conducted an economic valuation study of indoor air pollution and undertook the Decentralized Energy Planning Project, the main objective of which was to devise and implement pilot projects aimed at conserving fuelwood and kerosene in selected villages. It was strongly felt that energy interventions should be integrated with other development activities, in particular, infrastructural developments. A wide range of renewable energy technologies was disseminated. These included improved stoves, biogas plants, solar cookers and solar water heaters. By the end of 2003, over 1000 rural families had benefited from the project by using environment friendly cooking and heating technologies. It is expected that the project will result in annual savings of 11,000 liters of kerosene and about 650 tons of biomass (equivalent to 600 full grown trees). Total monetary savings are in the order of Rs. 7 lakh[36] (US$ 16,0034)[37] per year.

Winrock International India (WII)

WII is a non-profit organization working in the areas of clean energy, natural resources management and climate change. The organization has extensive experience with solar PV lighting, managing water and forestry resources and clean development mechanisms (CDM). In the field of household energy, Winrock India has assisted with World Bank's review of the Government's stove program (NPCI) and has evaluated the national biogas program (NPBD) as implemented by Gram Vikas, the leading implementing NGO in the state of Orissa.

In addition to the organizations discussed, others like Action for Food Program (AFPRO) and the Aga Khan Rural Support Program (AKRSP) have considerable experience in implementing community level household energy programs. Their activities are further discussed under the following section.

Multilateral Institutions

United Nations Children's Fund (UNICEF)

One of the main priorities for UNICEF in India is reducing infant mortality rates by interventions in the areas of health, nutrition, safe water and sanitation. In 1992, UNICEF in collaboration with the World Health Organization launched the Integrated Management of Childhood Illnesses (IMCI) program that attempts to combine the lessons learned from various health issues into an effective approach for managing sick children. IMCI is the umbrella initiative through which all community based health interventions can be implemented. IMCI works through various government health interventions and in India addresses issues like ARI, malnutrition and other leading childhood illnesses. To date the biggest challenge for this approach has been to identify the exact cause of death for children under five. Children chronically die of multiple causes and it is often difficult to ascertain the primary cause of death. This is further compounded by poor vital registration systems in many of these countries. However, IMCI related questions have been included in nationally representative surveys like the Multiple Indicator Cluster Survey (MICS) and the Demographic and Health Survey (DHS). Results from these surveys indicate the progress made to date and provide guidance for future actions.

[36] 1 lakh = 100,000
[37] US$ 1 = Rs. 43.65

World Vision, India

World Vision started its activities in India in 1962 and since then has grown to focus on a large number of developmental and relief issues. The Organization works in 24 states and relies on networking with the local communities, governments and NGOs. In addition, the creation of women's self help groups is a key element in the implementation of various developmental and income generating activities of the organization's programs across the country.

World Health Organization (WHO)

The World Health Organization has been involved in providing support for some of the country's major health programs. These include the program on immunization, tuberculosis, malaria etc. The Roll Back Malaria (RBM) initiative was launched in 1998 in collaboration with the United Nations Development Program (UNDP), United Nations Children's Fund (UNICEF) and the World Bank. The global partnership aims to halve the world's malaria burden by 2010. In India, where there are 192 malaria cases per 100,000 people[38], the program will begin in five districts where there is a severe malaria problem[39]. A national committee has been formed constituting researchers and members of the national anti-malaria program. In India, the WHO provides support for several other initiatives including the government's Universal Program on Immunization and the National Tuberculosis Control Program.

World Bank

The World Bank in India has several ongoing projects in the areas of infrastructural development, water and sanitation, poverty alleviation, education, malaria control, women's empowerment and reproductive and child health[40]. To date, India is the largest single cumulative recipient of World Bank aid, totaling more than US$ 59 billion. The Bank's 2000 – 2004 Country Assistance Strategy aims to 'Strengthen the enabling environment for development and growth' and 'Support pro-poor interventions'. These objectives will be fulfilled by: improving government effectiveness; encouraging the growth of the private sector; making health and education accessible to all; and encouraging pro-poor development through community based activities directed at the most vulnerable groups. One of the largest Bank programs in the country is the 'Population and Child Health Program', which dates back to the early 1970s. The organization has made substantial investment in the Government's Child Survival and Safe Motherhood Project (CSSM), funding to which totals about US$ 645 million. In addition the Bank continues to provide assistance to the national immunization program, programs in safe motherhood, and the control of acute respiratory infections and diarrheal disease.

The Bank has also launched the Clean Air Initiative for Asian Cities to address air quality issues of these highly congested areas.

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[38] Roll Back Malaria, Country Profile: India, October 7, 2003 <http://mosquito.who.int/cgi-bin/rbm/dcountryprofile.jsp?BV_SessionID=@@@@0200745579.1065545326@@@@&BV_EngineID=cadcihgfkhllbeimcghgcfgdgo.0&service=rbm&com=gen&lang=en&channelId=-8256&country=IN>

[39] Although this statistic is not as high as some countries (like Congo where there are over 5,500 malaria cases for every 100,000 people) in India, over 973 million people live in malarious areas making early intervention a high priority to prevent epidemics.

[40] The World Bank Group India, September 25. 2003. < http://lnweb18.worldbank.org/sar/sa.nsf/India/OpenNavigator>

Clean Air Initiative for Asian Cities (CAI – Asia)

The Initiative aims to promote and demonstrate innovative ways of improving the air quality of Asian cities through partnerships and shared experiences. Indoor air pollution is one of the key areas of focus and for this purpose the World Bank jointly organized an International Workshop on Household Energy, Indoor Air Pollution and Health. The workshop was held in New Delhi in May 2002. In addition, as part of ESMAP the World Bank has evaluated the government's LPG program, Deepam Scheme, in Andhra Pradesh and has conducted evaluation and assessment studies of the government's National Program on Improved Chulhas (NPIC) and the rural energy situation of the country. The findings of these studies are discussed in greater details under the section titled 'Household Energy Programs and Projects'.

VII. INDOOR AIR POLLUTION AND/OR HOUSEHOLD ENERGY PROGRAMS AND PROJECTS IN INDIA

Overview

The Government of India has embarked on several household energy programs since the early eighties. Most of these programs were implemented and managed by the Ministry of Non-Conventional Energy Sources. Some of the key interventions include the National Program on Improved Chulhas (NPIC), the National Project on Biogas Development (NPBD), the Deepam Scheme (LPG) in Andhra Pradesh and the Box Solar Cooker Program. In addition a kerosene scheme provides the fuel at subsidized prices. Brief introductions to these programs are followed by discussions on results and lessons learned according to the Partnership for Clean Indoor Air's four areas of key focus described in the next section.

National Program on Improved Chulhas

An Improved Stove in Use in Haryana
Source: Ministry of Non-conventional Energy Sources <http://mnes.nic.in/frame.htm/majorprog.htm>

One of the most notable household energy programs was the Indian National Program on Improved Chulhas, which was launched in 1983 and ended in 2000. The program's primary aims included reducing the demand on fuelwood to address widespread deforestation and fuelwood scarcity in certain areas and removing smoke from kitchens. The program aimed to disseminate improved clay and mud stoves. The central government with six regional officers and several others in the state and district managed the program. By September 2000, 32 million stoves of various types had been disseminated. A 1995 survey by the National Council of Applied Economic Research (NCAER) in 18 states indicated that 71% of the cook stoves were in working order and 60% were in use. Please refer to Table D1 in Annex D for more information on the number of stoves disseminated by state. The Program disseminated these stoves by providing subsidies, which varied from 75- 90% of the cost. The Ministry of Non Conventional Energy Sources (MNES), the key implementing agency, involved various other government entities, educational institutions, NGOs, and rural entrepreneurs for the dissemination of these stoves.

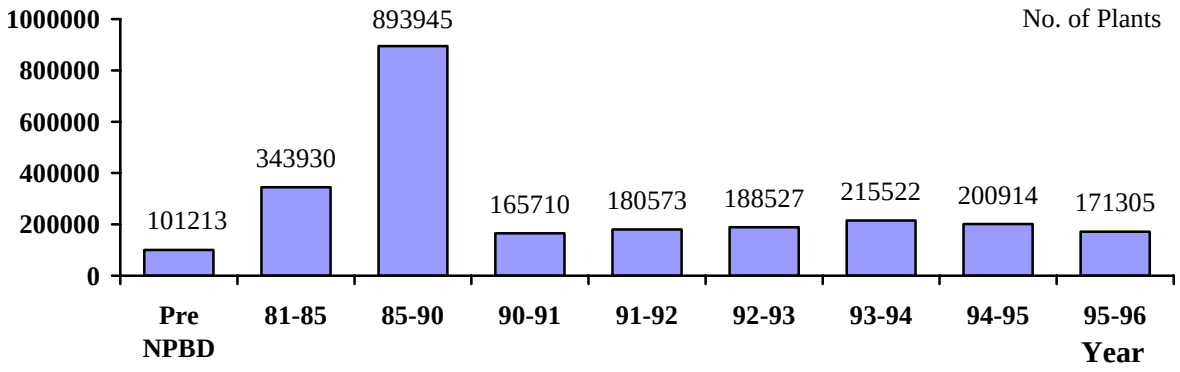
National Project on Biogas Development

Deenbandhu Plant in use in Arunachal Pradesh
Source: Ministry of Non-conventional Energy Sources
<http://mnes.nic.in/frame.htm?majorprog.htm>

The National Project on Biogas Development (NPBD), which started in 1981and is still ongoing, had several objectives. Some of these included providing clean unpolluted energy, reducing the pressure on fuelwood supplies, eliminating smoke filled cooking environments, reducing drudgery and preventing eye infections. The MNES adopted a target-oriented approach to disseminate the biogas plants through designated nodal agencies in each state. Refer to Table D3 in Annex D for a listing of these agencies. The number of plants to be disseminated in a certain region was determined by the target number set for the previous year and not the actual need of the region. Local masons initially constructed the plants however during 1986/87 Turn-Key Workers (TKWs), unemployed or semi-employed youth were involved in the process of plant construction and dissemination.

The following chart depicts the total number of household plants installed every year until 1996. It is observed that biogas plant installations peaked in the initial years of the program but dropped dramatically after 1990. Refer to Table D4 in Annex D for an updated list of state-wise installation of biogas plants till March 2003.

Figure 7 Installation of Household Biogas Plants



Source: Ramana {1991}. TEDDY {1997}, MNES {1998} as cited in Venkata R. Putti, "As if Institutions Matter: An Assessment of Renewable Energy Technologies in Rural India," Technology and Development Group, University of Twente, The Netherlands, 1998

The Ministry commissioned periodical evaluation studies to assess the functionality of these plants. Evaluations were also conducted by the NCAER in 1992/93. These ministerial studies found that nationally, about 84% - 88% of the plants were functioning. Most of the states in fact had more than 70% of the plants working. However, the NCAER study found an overall functionality of about 60%[41]. Other studies conducted at the time also reported mixed results[42]. Plant functionality varied

[41] 6% of the plants were partially working, 20% were dysfunctional, 5% uncommissioned, 7% incomplete and 2% dismantled.
[42] A series of studies of the Janata plant in several states found that only 40% of the plants were functioning.

by states however the overall performance appeared to have improved over time. The fuelwood saving benefits of the biogas plants depended on the functionality of the plants. If it is assumed that 90% of the plants were functional then about 10 million tons of fuelwood (equivalent to US$ 98 million) would be saved every year.[43] However, since the NPBD reached only 2% of the rural households (according to the most optimistic estimate), this fuelwood savings does not add up to a significant proportion of the total amount consumed in the domestic sector. It is estimated that biogas has saved about 23 million tones of CO_2 emissions in the form of saved fuelwood.[44]

Deepam Scheme

The state government of Andhra Pradesh launched the Deepam Scheme in 1999. Compared to the NPIC and the NBPD, this scheme had a much smaller scale however, the findings indicate important lessons learned for future initiatives. Under this scheme the government paid the LPG connection fee (Rs. 1000/ US$ 22.90) for women who belonged to self-help groups and whose households were classified as being below the poverty line[45]. The initial target was to release 1.15 million LPG connections however, as of March 2002 over 1.5 million connections had been released through the Scheme. This included 1.2 million connections in rural areas. The scheme was designed to cover about 3 million households. Refer to Table D6 in Annex D for the state-wise allocation and release of LPG connections under the Scheme. The Departments of Rural Development and Civil Supplies and Public Sector were responsible for implementing the Scheme. The former identified potential beneficiaries while the latter was involved in the release of refundable deposits for gas connections to the oil companies; ensuring that an adequate number of cylinders and regulators were on-site; ensuring timely supply of cylinders and generally coordinating with the government agencies and LPG dealers, suppliers and technicians. It emerged from an ESMAP/World Bank assessment[46] of the Scheme that LPG supply was in fact not regular and this discouraged many households from either shifting to LPG or using the fuel on a regular basis. This is discussed in further detail under the section titled 'Market Development'. As mentioned earlier, the kerosene market in India is highly subsidized with urban dwellers receiving greater allocation than their rural counterparts.

Program on Box Solar Cookers

The Government's Program on Box Solar Cookers was not as successful as some of the previously discussed interventions and is briefly discussed below.

The Ministry of Non Conventional Energy Sources has been implementing the Box Solar Cooker[47] Program since 1982. Initially the program was subsidized. However, in 1993 the government adopted a commercialization approach. The program is being implemented by state government agencies and NGOs and to date over 500,000 solar cookers have been distributed.

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[43] Several assumptions are made for this calculation: 50% of the working plants assumed to be of m^3 capacity and the rest at 2 m^3 capacity; fuel wood savings at 1600 kg per annum per m^3; fuelwood price Rs. 1 to include opportunity cost; among others. For more information refer to Pg. 91 of Venkata R. Putti, "As if Institutions Matter: An Assessment of Renewable Energy Technologies in Rural India," Technology and Development Group, University of Twente, The Netherlands, 1998

[44] Venkata R. Putti, "As if Institutions Matter: An Assessment of Renewable Energy Technologies in Rural India," Technology and Development Group, University of Twente, The Netherlands, 1998

[45] Indicated by the possession of a white ration card.

[46] An Assessment of the Deepam Scheme in Andhra Pradesh, Indoor Air Pollution: Energy and Health for the Poor, ESMAP/World Bank, March 2002(6).

[47] An insulated box with a glass cover and a top lid. The box has a mirror on the inside to reflect sunlight into the box when the lid is kept open.

The cost of the cookers range from Rs. 1000 – 2500[48] and versions are available with and without electrical backup. The backup systems are promoted for cooking after daytime hours or during cloudy days. A regular cooker is sufficient for a family of 4 to 5 members and the device has a life of 15 to 20 years. The pay back time is estimated to be 3 to 4 years[49]. Other benefits of using solar cookers include no fuel costs, time saved in cooking, reduction in pollution and environmental degradation, no risks of fire related burns or injuries etc. Despite these benefits there are several reasons why the box solar cooker has not been widely adopted in the country[50]. These include i. The time factor: most of the rural populations involved in agriculture leave home before sunrise and therefore cannot take advantage of the daylight hours for cooking; ii. Cooking practices: Most Indian preparations include frying however the cookers can only be used for boiling and baking purposes. Moreover, rotis (hand made breads) are consumed in many areas and this cannot be baked on the cookers either; iii. The cost: The cookers are still too expensive despite subsidies and commercialization efforts and iv. The lack of infrastructure: Inadequate repair and maintenance have resulted in stove abandonment. The box solar cookers do not seem to be a feasible household energy option in the near future unless these key issues are addressed.

The following section discusses these key programs under the Partnership for Clean Indoor Air's four areas of key focus: i) Market development, ii) Technology standardization, iii) Health impact monitoring and iv) Social/cultural barriers.

Market Development

The Government of India heavily subsidized both the stove (NPIC) and the biogas (NPBD) programs. For the stove program, the builders were paid half the cost of the stoves resulting in the producers responding more to government-directed stove specifications rather than the needs of the customers. As a result many stoves had drawbacks, which included not accommodating household pots, not withstanding the heat generated or not combusting fuel efficiently enough to reduce fuel use. The adoption rates for stoves were low for households and these devices were not used and maintained properly. Although the poorest households received the highest subsidies (for example in some parts of the state of Maharashtra), the stoves often fell into disuse due to poor maintenance and lack of appreciation by the households. In the state of Haryana, many households claimed they would use the improved stoves as long as they lasted and would then revert back to using their traditional stoves[51]. High subsidies also discouraged private entrepreneurs from disseminating their own improved stoves.

However, the program showed considerable success where a commercialization approach was adopted. Between 1995 and 2000, nearly 800,000 stoves were installed in the state[52]. This approach was taken in areas where people generally paid for their stoves and/or there was scarcity of biomass fuels. Women typically spent long hours collecting fuel, using very low grade residual fuel or paying cash for fuelwood. In addition, the technical back-up unit for the area (the Appropriate Rural Technology Institute (ARTI)) provided extensive training to traditional potters and self-employed

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[48] US $ 22 – 55 (US$ 1 = Rs. 45.36)
[49] Solar Box Cooker, Ministry of Non-Conventional Energy Sources, October 16. 2003 <http://mnes.nic.in/frame.htm?majorprog.htm>
[50] Venkata R. Putti, "As if Institutions Matter: An Assessment of Renewable Energy Technologies in Rural India," Technology and Development Group, University of Twente, The Netherlands, 1998
[51] Douglas Barnes and Priti Kumar, "Success Factors in Improved Stove Programs: Lessons Learned from Six States in India", Paper to be published in Journal of Environmental Studies and Policy, TERI, India.
[52] Ibid.

workers to design, build and sell the improved stoves. The potters were also assisted with obtaining loans from local cooperatives and banks to establish local entrepreneurial units. These back-up units did not employ the same strategy in each state. For example, The Regional Engineering College in Warangal, the technical unit for the state of Andhra Pradesh, developed audio-visual publicity materials in local languages to disseminate information about improved stoves and increase adoption. Between 1995 and 2000, nearly 1.3 million stoves were installed in the state.

For the biogas (NPBD) program, the Government initially provided 100% subsidy to the beneficiaries to offset the high initial costs of plant installation. However, the subsidy was later reduced to 25% of the total costs. A subsidy pattern was designed keeping in mind the economic and physical disparities in various parts of the country. Populations belonging to scheduled castes and tribes, and those living in remote areas were given higher subsidies than medium and large-scale farmers. In addition, different levels of subsidies existed for different types of biogas plants. Table 1 below provides information on various amounts of central subsidy by plant size and region. However, there were instances when households installed higher capacities of plants (than the one their cow dung supply would justify) to take advantage of these higher levels of subsidies. This often led to plant failures and a new policy was adopted whereby the subsidy for plants with a higher capacity was fixed at the same level as plants with a capacity of 3 m^3.

Table 1 Central Subsidies under NPBD (in Rs.)

Capacity (m3)	**North Eastern States** (Sikkim; Jammu and Kashmir; Himachal Pradesh; 8 hilly districts of Uttar Pradesh; Andaman and Nicobar Islands and Lakshadweep)	**Scheduled Castes and Tribes** (desert districts small and marginal farmers; landless labourers; plain areas of Assam; Terai region of 2 hilly districts of Uttar Pradesh; Western Ghats; and other notified hilly areas)	**All Others**
1	2800	2000	1500
2	3200	2400	1800
3 & above	3500	2600	2000

Source: Venkata R. Putti, "As if Institutions Matter: An Assessment of Renewable Energy Technologies in Rural India," Technology and Development Group, University of Twente, The Netherlands, 1998

In addition to subsidies, soft loans with low interests were offered to the beneficiaries to meet the costs that could not be recovered by the subsidies alone. The nationalized banks disbursed these loans under the Government's Automatic Refinancing Scheme. Under this scheme, raw materials were available at reduced prices. To qualify for these loans, households had to meet certain criteria such as a minimum number of cattle or land. It appears that these financial schemes were not very successful due to the minimum criteria, which was difficult for most households to fulfill. Moreover, the subsidies were spread quite thinly due to the large number of target plants. The MNES also had special financing provisions for organizations that were involved in implementing the Project. The Nodal agencies also received additional financial incentives for installing plants above the targeted number.

The Deepam scheme is one of the few interventions that did not heavily subsidize the costs involved. The scheme was based on a one-time subsidy for part of the LPG connection costs rather than LPG refills. The beneficiaries had to cover the upfront cost, which included stove and connection

accessories at about Rs.1,000[53]. The scheme also targeted the Scheduled Caste (SC) and Scheduled Tribe (ST). Over 80% of the beneficiaries purchased the stove and accessories from their own funds while others obtained loans from the self-help groups under the Development of Women and Children in Rural (or Urban) Areas (DWCRA or DWCUA)[54]. The gas agencies were required to deliver refill LPG cylinders to homes to the extent possible[55]. However, many claimed that they could not rely entirely on home deliveries due to an inadequate LPG distribution infrastructure. The refill costs ranged from Rs. 250 – 300[56] (Mid 2001) depending on the location of the nearest dealer.

It appears that other factors including the interaction between producers, implementers and users; role of the technical units and user perception of these energy efficient technologies etc. affected the adoption of the stoves and biogas plants as well. Urban households used much more LPG than their rural counterparts and LPG use was highest during harvest seasons when the opportunity for earning cash income was also the greatest. Unfortunately, fuelwood remained the primary fuel for rural households, many opting to use LPG only for cooking tasks like making tea.

Although high subsidies created increased reliance on government support and hampered the sustainability of the interventions, the Deepam Scheme illustrates that infrastructural development is equally important for the success of these interventions. Moreover, consumers or users must have a range of technology choices to select from and not be forced to adopt a single intervention.

Although kerosene has been subsidized so that households have better access to the fuel, much of the government allotted kerosene gets diverted to the black market and other sectors due to the varied uses of fuel, for example as automotive diesel. In the fiscal year 1999-2000, as much as half of the kerosene was lost this way at a cost of Rs 40 billion (about US$ 1 billion) to the Central Government[57]. According to the National Sample Survey, one of the most comprehensive household surveys in India covering information on household energy use, almost all poor households use small amount of kerosene for lighting, even if the total amount they are using is less than the allotted subsidized quota. A World Bank study[58] has found that providing a modest amount of cash to rural families may not necessarily encourage them to purchase cleaner fuels like kerosene. In fact, fuel switching may not be a household priority and raising awareness about the health benefits of using cleaner fuels, in combination with other mitigation measures, may be one of the most successful interventions to promote a transition to cleaner fuels.

Technology Standardization

Both the biogas and stove programs had very strong technical backup components and worked in a centralized manner. The expertise developed and the knowledge disseminated is one of the strong points of both programs and should be taken into consideration if either program is to be modified or revived.

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[53] US $ 21.90 (US$ 1 = Rs. 45.36)

[54] DWCRA/DWCUA – Scheme under the Government's Integrated Rural/Urban Development Program whereby 10 – 15 women are gathered into groups (based on mutual interest) and a one-time grant of Re 15,000 (US$ 331) is available from the government to initiate income-generating activities.

[55] At the state level the Andhra Pradesh government gave up 5 liters if kerosene for every new Deepam beneficiary enrolled in exchange for increased allocation of subsidized LPG by the central government to cover the scheme.

[56] US$ 5 – 7 (US$ 1 = Rs. 45.36)

[57] Energy Strategies for Rural India: Evidence from Six States, UNDP/ World Bank Energy Sector Management Assistance Program (ESMAP), August 2002

[58] Ibid.

For the stove program, a technical back-up unit (TBU) was set up in each of the 28 states to ensure that the stoves developed were meeting the required specifications[59]. Although several different models of fixed and portable stoves were developed under the Program at the state level, only a few models were disseminated and users had limited options to choose from. Many stoves could not be adapted to local conditions and preferences, and the users often altered the stoves after installation. Moreover, the stoves were built in individual households and the dimensions of the stoves often changed in the process of custom installation. This resulted in the loss of efficiency. In many cases, uncertified self-employed workers[60] installed stoves that had structural defects and led to other problems. Although stove makers were instructed to purchase stove parts only from approved suppliers, many stove makers purchased lower grade materials from the marketplace. In some cases the self-employed workers did not provide the one-year post installation service that came with the stove. This meant that the responsibility of resolving these problems was left to the users.

In addition, there was no uniform policy regarding the responsibility of the Technical Backup Units in approving or supporting the modification of stoves by various NGOs or self-employed workers. Sufficient funds were also not available to train the users. For example, in Karnataka, only 6% of the users had participated in a training program hosted by the technical unit. This was partially due to the minimal interaction between these units, the users, self-employed workers and NGOs. The World Bank study[61] indicates that apart from Maharashtra and Haryana all the other state programs evaluated faced similar communication challenges. In some cases the technical efficiencies of the stoves were deemed more important than the needs and requirements of the users.

However, there are instances where the technical units have played a leading role in disseminating the stoves. An example is the Appropriate Rural Technology Institute (ARTI), an NGO, which was designated as the TBU for the state of Maharashtra. The institute is involved in designing and testing new versions of stoves and providing extensive training to potters and self-employed workers for building, designing and selling improved stoves. As already mentioned, potters were also assisted with securing financial support from various entities. ARTI initiated a commercially oriented approach to stove dissemination since households in rural Maharashtra tend to purchase traditional stoves. As a result of strong support from the ARTI, 25 entrepreneurs in Western Maharashtra earned reasonable profits from selling the improved stoves in open markets. Improved stove models in Maharashtra included one and two pothole models with chimneys and a two-pothole version without chimney. Average stove efficiencies ranged from 24-28%. Please refer to Table D1 in Annex D for more information on various stove models in selected states. Their association with the National Stove Program, through ARTI, also provided further endorsement of their products.

Two designs of biogas plants were initially approved by the Ministry for the Biogas Project. These were the floating dome model of Khadi and Village Industries Commission (KVIC) and the Janata model of Planning Research and Action Division (PRAD). Several other models were introduced later to better respond to local needs. The Deenbandhu model, discussed in more detail later, gained the most popularity due to its low installation costs. In order to ensure widespread dissemination, the NPIC introduced the innovative concept of turnkey workers (TKWs). Refer to Table D5 in Annex D for more information on various models of biogas plants approved under the Biogas Project. Turnkey workers are unemployed or semi-employed youths in rural areas who are given a target number of biogas plants to disseminate in one or more villages on a turnkey basis (the workers were responsible

[59] The TBUs could be designated government agencies, NGOs etc.
[60] Only self-employed workers certified by the technical back up unit were authorized to build and install stoves.
[61] Douglas Barnes and Priti Kumar, "Success Factors in Improved Stove Programs: Lessons Learned from Six States in India", Paper to be published in Journal of Environmental Studies and Policy, TERI, India.

for all stages of dissemination). However, the turnkey workers require approval from the nodal agencies. For every plant constructed the agency paid a fee to the worker in exchange for a 3-year warranty on the plant. During this period, the workers ensured smooth plant performance and conducted minor repairs at their own cost. In smaller states, NGOs were given the responsibility of implementing the project on a turnkey basis.

Health Impact Monitoring

Although eliminating kitchen smoke was one of the main objectives for both biogas and improved stove programs, it is not clear if it was aimed at improving health conditions. Measurements of levels of indoor air pollution were not taken to assess the effectiveness of these interventions. Moreover, there were no formal efforts to disseminate information regarding the health benefits of these technologies to the producers and users.

For the NPIC, the technical backup units were instructed to install a chimney to the fixed stoves in an effort to eliminate smoke. However, various problems arose with the installation of chimneys to fixed stoves and in some states like Maharashtra, the state government started to focus on disseminating portable metallic stoves (without chimneys to be used outdoors). Consequently, most users were forced to accept the metallic stove since the fixed stoves were not readily available. The end result was that the government's target for stoves had been fulfilled however, the 'beneficiaries' continued to use their traditional mud/clay cook stove since the portable versions were traditionally not used for day to day cooking in the region. In Karnataka, many users had to modify or remove their chimneys to avoid leakage of the thatched roofs during the rains.

Although over 3,500,000 biogas plants have been installed under the biogas program (NPBD), information is not available on whether or not the biogas stoves are used independently or in conjunction with biomass stoves. This would have an impact on indoor air quality; however conclusions cannot be dawn in the absence of relevant data. The case study of the NGO Gram Vikas (at the end of this section) indicates that in some instances potential users (or women) were informed about the elimination of smoke from cooking environments.

Exposure monitoring was conducted under the LPG (Deepam) Scheme in Andhra Pradesh. However it indicated that unless LPG becomes the primary fuel, levels of indoor pollution would continue to remain high. Women, although aware of the immediate physical comforts of a smoke-free environment, were not aware of the long-term health impacts of smoke. The Andhra Pradesh Government plans to add 1.3 million new connections under this scheme at a cost of Rs. 1.3 billion. It is not known if this component will include air quality monitoring or an awareness-raising component.

The Environmental Protection Agency (EPA) has commissioned some studies for monitoring exposure to indoor air pollution in households in Northern India. Further information will be provided on this study. However, this indicates future possibilities for interventions in the country, based on information obtained from such existing studies.

Social and Cultural Barriers

As with many improved stove programs worldwide, the stove program (NPIC) did not emphasize user interaction during the planning and implementation phases of the Program. The exception is perhaps the case of Haryana where the Department of Women and Child Development (the NPIC implementing agency in the state) developed the improved stoves with direct input from its network of over 7,000 women's groups (Mahila Mandals). Refer to Table D3 Annex D for a state-wise list of nodal departments and agencies involved in the implementation of the stove program. In addition

there has been extensive interaction between women and the stove designers (at the Punjab University's Energy Research Center) to design various models of stoves including stoves with chimneys and dampers, stoves with cement components, less polluting stoves that use dung cakes (to simmer milk all day long). About 237,000 new stoves were installed in the state between 1995 and 2000. However, information on the health benefits of reduced kitchen smoke was not included. Moreover, a lack of feedback to the designers from the users and implementers in the field resulted in the construction of stoves that were difficult to maintain. Despite these drawbacks, there appears to be ample opportunity to harness the resources of the women's groups in order to improve feedback and user interaction and disseminate relevant health related information. Similar women's groups operate throughout the country and involving them through an NGO network or a government department (as mentioned above) might strengthen the reach and effectiveness of future interventions.

The biogas project, much like the stove program did not have adequate interaction with the cooks (primarily women). However, Gram Vikas's biogas program did involve women's groups or Mobile Women's Teams (MWT) which educated women about plant maintenance; the ratio of cow dung and water mix for the digester; cleaning biogas stoves; removing water from the gas pipelines and minor plumbing works. However, long hours of travel, and overnight stays at remote locations (which at times were not socially acceptable or deemed unsafe) discouraged women from participating further and the eight Teams were discontinued after the program ended in 1995[62]. No information is available on the dynamics of interaction between the Teams and the rural women and whether or not training by the women had in fact resulted in better maintenance and upkeep of the plants and therefore longer usage.

In addition to women's involvement, area specific cultural and fuel management practices need to be addressed as well. As is evident from the experience of the NPIC, areas where women spend long hours for fuel collection may have greater potential for an improved stove or biogas program. Similarly, creating income generating opportunities for women; for example for the time saved in cooking and fuel collection or for the slurry produced from biogas plants, may create further interest in adopting these interventions and ensuring their sustainability.

An evaluation[63] of the LPG (Deepam) Scheme revealed various issues, which ranged from women's perception of LPG to household practices in using the fuel. An overwhelming majority (97%) of the respondents stated that using LPG saved time for cooking. Other benefits[64] included: reduced time for collecting fuel (45%), time available for more labor (30%), social status associated with LPG use (9%), cleanliness (88%), and absence of smoke (45%). However, 13% thought that the use of LPG was 'unsafe'. In addition, many beneficiaries (84%) thought that the reduction in kerosene allocation was a disadvantage of the scheme. This was however restricted to urban dwellers since the rural beneficiaries, who receive only 3 liters of kerosene every month, did not have any reduction in the monthly allocation of this fuel. Eighty-nine percent of the beneficiaries wanted to see a reduction in the price of LPG while 14% said it was not affordable. Ninety-seven percent were satisfied with the selection process (as mentioned earlier women belonging to self help groups and whose households were below the poverty line qualified for the Scheme), 77% with the coverage and 65% with the

[62] Thomas, K. Sojan, Manager RHP, Gram Vikas, Email correspondence with Lutfiyah Ahmed, October 8. 2003.
[63] An Assessment of the Deepam Scheme in Andhra Pradesh, Indoor Air Pollution: Energy and Health for the Poor, ESMAP/World Bank, March 2002(6).
[64] By percentage of respondents

distribution arrangements. LPG was used most during the monsoons,[65] with its use lowest during summer when wood continued to be used as the main fuel for cooking, heating water and other non-cooking purposes. LPG was mainly used for other purposes like making tea or simple tasks for which getting a wood fire ready would be too time consuming. Average LPG consumption was 2.9 kg/month and the average rate of refill was once every 7 months. Urban areas consumed more (4.8 kg/month) vs. rural areas (2.6 kg/month) possibly due to better infrastructure, which allowed LPG users to have improved access to refill and repair services.

Apart from the relatively high costs of LPG, it would be interesting to investigate what other factors determine household cooking practices and what effect traditional cooking and fuel management practices have on LPG adoption and use. The safety issue needs to be further addressed since LPG is used from cylinders and the users require some basic information about cylinder handling and maintenance.

Behavior change communication forms a key part of any intervention where the beneficiaries are expected to adopt behaviors or practices that would lead to a positive outcome. Examples of behavior change interventions in household energy were not readily available. However, there are some innovative approaches that have been adopted by the health sector. One such intervention, 'Meena the Girl Child' has strong potential for addressing indoor air pollution and health related issues as discussed below.

Meena the Girl Child: Tool for Behavior Change Communication

"Meena" was launched by UNICEF South Asia in 1998 as a 13 part animated series broadcast by both private and public radio and television channels. The series is also used as a teaching aid in school programs across the region. The story lines are based on real life challenges faced by girl children in South Asia. Meena confronts various issues like girl's education, proper nutrition, early marriage etc. The series depicts how girls and their families can bring about a positive change in their lives by developing problem solving and communication skills. The target audience for the series was not only children but also adults who are very often the decision makers for young children. In India, the Meena episodes were translated into dozens of languages and interactive activities like quiz competitions, essay contests, rallies, sporting events, camps and children's art exhibitions were promoted to actively involve young people and reinforce the importance gender plays in their lives. Meena was also integrated with other campaigns and programs for children like the Global Movement for Children launched in 2002.

In order to reach audiences who do not have access to modern communication channels like radios and televisions, plays and puppet versions of the series were staged in states like Bihar and Orissa. The Government of India was also extensively involved in promoting Meena. UNICEF worked with the government's division of Integrated Child Development Services (ICDS). Under this program, more than 18,000 "anganwadi" workers[66] were trained to impart gender sensitive lessons through the Meena initiative. About 20,000 community based discussion groups, Anganwadi Centers, have been set up around the country. In addition UNICEF mobilized about 300,000 youth clubs under the National Ministry of Youth Affairs to include more gender sensitive programs in their curriculum. The Ministry of Information and Broadcasting has disseminated information about Meena by

[65] The reasons included: more cash available to agricultural laborers after the harvest; less time for biomass collection and cooking; difficulty in keeping fuel dry.

[66] Women working in Anganwadi Centers set up under the ICDS program. These Centers act as a meeting ground for women's/mother's groups to promote awareness and action for child's development and women's empowerment.

incorporating relevant information in their community-based programs like drama, entertainment and folk traditions. Meena clubs for children were formed around the country and local village councils (panchayats) were using Meena materials to advocate for girl children. Various regions of the country adopted different approaches to disseminate information about Meena. In West Bengal, a musical was composed to depict the struggles of a girl child who overcomes various gender-based stereotypes and obstacles. In Bihar, the Meena initiative led to the establishment of Bal Samachar, a newspaper written by and for children to address gender issues.

Despite these efforts, critiques claim that very little has changed for women and girl children in India. There are claims that awareness-raising initiatives like cultural programs, theatre etc. make very momentary impressions on the audience. However, Meena is a first step towards changing attitudes and perceptions about the rights and roles of the girl child. The fact that Meena addresses a range of social and cultural issues of relevance to the entire community indicates tremendous potential for taking this initiative a step further and addressing other issues.

Meena's Prospect for Addressing Household Energy and Indoor Air Pollution

There are several ways in which Meena might act as a tool to raise awareness about household energy and indoor air pollution. Meena already addresses preventive measures for childhood diseases like diarrhea and advocates the use of Oral Rehydration Therapy as treatment. Incorporating information about the adverse impacts of IAP and basic preventive measures appears to be an incremental step that would be relatively easy to include in the series. However, it must be borne in mind that using Meena alone would not be sufficient to raise awareness since past experiences with other issues (girl's education, dowry etc.) have demonstrated that a multi-pronged approach is required to address the issue from all channels. Other complementary interventions in the field of household energy and health will have to be undertaken in order to have a lasting impact. In addition, Meena has a well-established network of government and NGO counterparts working to promote the initiative in their programs. One such example is the government's Integrated Child Development Services program discussed earlier. Among the objectives of the ICDS are "To improve the nutritional and health status of pre-school children aged 0-6 years" and "To enhance the capability of the mother to look after the normal health and nutritional needs of the child through proper health and nutrition education."[67] The Anganwadi workers under this program are already involved in raising gender-based awareness through the Meena initiative. This coupled with the fact that these workers already disseminate health information, presents an ideal opportunity for raising health awareness about IAP. It can be safely assumed that ARI information is already disseminated as part of the child health and nutrition component. Information about IAP as a potential risk factor for ARI and associated preventive measures would again be an additional measure easily undertaken in the existing framework.

This two pronged approach with ARI and health information being disseminated through a) the Meena series and b) the Anganwadi workers (further strengthened by their existing knowledge of ARI detection and treatment) under the aegis of Meena and the Integrated Child Development Services program would have the effect of addressing the issue more comprehensively and bringing about desired behavior changes. The Anganwadi workers may be able to focus on the mother's role in reducing/preventing exposure to IAP by gaining from their pre-existing relationship with mothers and women's groups.

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[67] 'Child Development', Department of Women and Child Development, Government of India, October 3, 2003 < http://wcd.nic.in/childdet.htm#i2>

Case Studies

The following case studies of three NGOs (Gram Vikas, Action for Food Production (AFPRO) and the Aga Khan Rural Support Program) illustrate how various aspects of the four focus areas discussed so far can be combined to design and implement a successful household energy program.

Biogas Program of Gram Vikas in Orissa

Gram Vikas (GV), a non-governmental organization, established in 1979 was one of the leading NGOs in implementing the Government of India's biogas project in Orissa. At the time of the project implementation, the organization already had some prior experience with biogas plants. In collaboration with AFPRO-CHP[68], Gram Vikas developed the Deenbandhu model biogas plant. The Deenbandhu required less cement to build and therefore cut down construction costs. From 1986 only the Deenbandhu model of the plant was installed. By the end of the program in 1996 the Deenbandhu model accounted for 94% of the 54,000 plants installed (in nearly 6000 villages covering 13 districts of Orissa).

Since there was some misconception about the effectiveness of biogas plants, Gram Vikas started by targeting rich, educated and influential families to have a demonstration effect and to motivate other inhabitants into installing a plant. The NGO also started to conduct training programs on plant construction for state personnel and other masons. A total of six such programs were conducted in various parts of the state and approximately, 550 masons, 50 work sarkars and 6 supervisors were trained in the construction of biogas plants. However, it is not known if households were exclusively using biogas burners for cooking purposes or if traditional stoves were used simultaneously. In addition, if the biogas produced was used for lighting purposes then there may not be enough fuel to cook with. This would again result in the use of traditional cook stoves. This highlights the complexity of household dynamics and the importance of women's decision-making power in the family for a household energy project to be successful. Gram Vikas also employed eight Mobile Women's Teams to train users (women) on the construction and maintenance of these plants. Further information is provided under 'Social and Cultural Barriers'.

When the project ended in 1995, Gram Vikas conducted a 100 percent plant verification survey and found that 60 percent of the plants were functional. With the help of some funding from The Norwegian Agency for Development (NORAD), the NGO undertook the restoration work for the 8,700 dysfunctional plants that could be restored and the plant functionality improved to 76 percent at the time the project ended. The biogas projects gave rise to the Rural Health and Environment Program (RHEP) whose main objective was to "meet the health and environmental needs of the rural community through the provision of basic infrastructure in conjunction with people's mobilization and empowerment."[69] Further information on this program has been provided under the 'Key Actors in Health' section. Some biogas plants are still constructed under this program. In addition, the large number of masons and technicians who were trained under the NPBD were encouraged to embark on independent ventures. Gram Vikas stood as guarantors for turn key entrepreneurs (for banks, cement dealers etc.). Many were given certificates and liaised with government agencies for employment. This ensured that the technical knowledge imparted to these workers was constantly applied in the field, resulting in further dissemination of biogas plants and a steady source of income for the workers.

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[68] Action for Food Program – Canadian Hunger Foundation, financial support to AFPRO was provided by CIDA through the CHP. Further detail is provided under AFPRO's biogas activities.

[69] Rural Health and Environment Program, Gram Vikas, October 8. 2003
< http://www.gramvikas.org/>

(Source: Venkata R. Putti, "As if Institutions Matter: An Assessment of Renewable Energy Technologies in Rural India," Technology and Development Group, University of Twente, The Netherlands, 1998)

AFPRO's NGO Network for Biogas Dissemination

AFPRO is a national level NGO providing technical and program services to grassroots levels NGOs. The organization started to implement a biogas dissemination project in the early 1980s with financial support from The Canadian International Development Agency (CIDA). The project was implemented in two phases: during 1984-90 and then from 1990-97. Under the program, AFPRO developed a network of grassroots NGOs who were given funding to create a local infrastructure and carry out all stages of disseminating biogas plants. In addition, AFPRO set up a field station in Aligarh, Uttar Pradesh to conduct research and development on biogas. Further efforts to decentralize the program were made by setting up Regional Consultative Groups (RCGs) comprising these NGOs in 8 regions. These groups met twice a year to discuss various issues including problems faced and possible solutions. Village level service units were also set up to conduct post installation maintenance and other related functions. The program beneficiaries had access to the subsidies and loans offered by the NPBD.

The Aligarh research station developed the Deenbandhu model, which later on became the predominant model of biogas plant used. In 1995 another new model, the Sramik Bandhu, was developed. This model uses bamboo in place of bricks and was cheaper than the Deenbandhu model. The AFPRO network installed over 97,000 plants over 12 years and it is estimated that these plants replaced nearly 300,000 tones of fuelwood every year in addition to producing 4 – 5 million tons of slurry fertilizer and generating 5 million person days of direct employment.

The success of this program can be attributed to the decentralized process of working with the grassroots level stakeholders. For example, most of the plant builders and motivators were native to the villages where the program was implemented. The masons were given adequate training in plant construction and in some areas they were paid directly by the households after quality checks had been conducted for the plants. In addition, the grassroots NGOs organized community demonstrations with the help of staff members who had a good rapport with the local community. In some instances, local political leaders and women's groups were involved in motivating local farmers and other prospective users. Women were involved more effectively by being employed as project staff or through village institutions like Mahila Mandals (women's associations). Housewives were given access to financing through micro-credit schemes and some NGOs also trained local women to carry out repair and maintenance. All participating NGOs contributed to a central fund through which sustainability of the NGO network was ensured.

(Source: Venkata R. Putti, "As if Institutions Matter: An Assessment of Renewable Energy Technologies in Rural India," Technology and Development Group, University of Twente, The Netherlands, 1998)

Aga Khan Rural Support Program's Biogas Project in the Gir Forest Sanctuary, Gujarat

In the Gir Forest Sanctuary in Gujarat, the people who have been displaced by its creation live on its periphery and collect fuelwood from the forest. Increasing population pressure resulted in people encroaching into the sanctuary, threatening wildlife conservation efforts. A state-level NGO, the Aga Khan Rural Support Program (AKRSP), started a biogas program, in 1986, in the area in collaboration with the AFPRO network (discussed above), the NPBD and the Gujarat Agro-Industries Corporation, the state nodal agency for the biogas project. Target villages were selected through a process of participatory rural appraisal during which factors like fuelwood availability; cattle ownership and the number of households willing to install the biogas plants were considered. After the selection process, village institutions and women's groups were created to oversee the project design and management (which included selecting the biogas beneficiaries). In addition, the workers responsible for installing the

plants were selected from the local villages and given relevant technical training. In the Baruch district of Gujarat, some women were also implementing these plants as turkey workers. Regular training camps and masons meetings were organized to maintain quality control and accountability. The subsidy the NGO received from the Government was used to purchase raw materials in bulk and store them at block level distribution centers. This ensured uniform quality and reduced costs.

Evaluation studies reported that households were consuming less fuelwood, dung cakes and kerosene for cooking. In addition, women were saving money and time spent in fuelwood collection and management. There is some evidence that women were using this extra time for productive purposes like knitting and better care of the children and family. Moreover, women appreciated the smokelessness and cleanliness of their kitchens from using biogas. This example illustrates that employing a participatory approach with the stakeholders can result in a successful intervention even if broader government initiative has various drawbacks. Women's involvement in the project has been particularly important not only in terms of incorporating their input but also creating income-generating opportunities that have further ensured project sustainability. This would provide an ideal opportunity to incorporate information about indoor air pollution and associated health impacts in order to increase awareness and stove adoption. The program is still ongoing in the State.

(Source: Venkata R. Putti, "As if Institutions Matter: An Assessment of Renewable Energy Technologies in Rural India," Technology and Development Group, University of Twente, The Netherlands, 1998)

VI. LESSONS LEARNED AND RECOMMENDATIONS FROM HOUSEHOLD ENERGY INTERVENTIONS IN INDIA

While most of the lessons learned and recommendations are in a program specific context, one of the overarching findings has been the absence of health information (specifically on indoor air pollution and its adverse health effects) in these programs.

Using Women's Groups and NGOs to Incorporate Health Related IAP Information for Dissemination and Adoption of Clean Cooking Technologies

A study[70] that compared the NPIC stove program in six Indian states found that in the state of Haryana, nearly all users appreciated the benefit of reduced smoke in the kitchen while there was little awareness about the reduction in fuel use or the adverse health impacts of smoke. This indicates considerable potential to include IAP related information into the program if it were to be revived. Incorporating relevant information may not only generate further demand (as a means of preventing/reducing exposure to IAP) for the stove but also lead to better usage and maintenance of stove and stove parts like chimneys. Although women were aware of the immediate physical discomforts of smoke (eye irritation, difficulty in breathing etc.), they were not aware of the other health impacts of smoke especially for young children. Women's groups can be involved in information dissemination. As already mentioned in Haryana the Department of Women and Child Development implemented the NPIC through its network of more than 7,000 Mahila Mandals (women's groups). These women's groups usually address maternal and child health issues and incorporating IAP related health information into their curriculum would be relatively easy to accomplish. There already exists extensive knowledge about the diagnosis and treatment of ARI.

[70] Douglas Barnes and Priti Kumar, "Success Factors in Improved Stove Programs: Lessons Learned from Six States in India", Paper to be published in Journal of Environmental Studies and Policy, TERI, India.

Therefore, IAP information could be included as another part of the 'ARI package'. These women's groups could disseminate the stoves as a means of reducing/preventing harmful smoke exposures in addition to the fuel and time saving benefits of the technology.

Although reducing smoke in the kitchens was one of the objectives of the biogas project, this particular benefit of using biogas was never publicized to the users. This is indeed a missed opportunity since in areas where the project was successful the women valued the elimination of smoke from their kitchens. Information on the adverse health impacts of indoor air pollution was not included at any stage of the program although, there was opportunity for such information to be disseminated through the NGOs, turn key workers and other implementing agencies.

This is particularly true for NGOs like the Self Employed Women's Association (SEWA) an organization exclusively managed by women with networks throughout the country. Aga Khan's program experience with involving women in plant design and implementation phases has been very positive. These women could also be involved in disseminating relevant information on IAP, adverse health outcomes, and using biogas for reducing or eliminating harmful smoke exposures. Although Gram Vikas's Mobile Women's Teams were discontinued after the program ended, the concept is an innovative one and may have more potential if local women are appointed for these teams. This would help address cultural issues like traveling long distances and being in unfamiliar surroundings. In addition to demonstrating the operation and maintenance of biogas plants, relevant information on IAP and health can be circulated as one of the benefits of this technology. It can be assumed that awareness of the health benefits of using biogas in conjunction with its fuel and cost saving aspects would make the technology more desirable and perhaps increase its demand.

Similarly, the Deepam Scheme had improving women's health status as one of its main objectives. Again, the beneficiaries were not given information on the health benefits of using LPG. However, nearly half of the women recognized reduction of smoke from their kitchens as a primary benefit of the scheme. There is an underlying concern that LPG use will never be optimal as long as various fuels (mainly residual fuels) are collected free of monetary cost. Since self-help groups were targeted for the promotion of the scheme, it is conceivable that incorporating health information and disseminating them through these groups may have some positive impacts and LPG may be adopted for fuelwood/time saving as well as health benefits. However, it should be borne in mind that simultaneous improvements in other areas like LPG infrastructure, and financing mechanisms are equally important for increasing IAP related health awareness and LPG adoption.

The following address specific household energy interventions:

Designing and Disseminating 'Appropriate' Stoves through User Involvement and Training

About 120 different stove designs were developed under the stove program[71]. However, all these designs were not successfully translated from the laboratories to the field settings. In fact, in many places, the users had very limited stove designs to choose from (mainly due to the TBUs adopting designs that were easy to implement) and as already mentioned this led to design modifications that compromised stove efficiencies. This reaffirms the importance of user involvement in the design development phase of the program. In addition, greater user training is needed to increase the understanding of stove principles and maintenance issues.

[71] Putti, V. Ramana. Interview with Lutfiyah Ahmed. September 24, 2003

Disseminating Stoves/Biogas Plants through Need Based Approach

The target-oriented approach of the stove program appears to be one of the main barriers to its successful implementation. Moreover, there was minimal interaction between the stove users, self-employed workers, NGOs and Technical Backup Units. In many cases the self-employed workers did not provide adequate after-sales services since there was no financial obligation. The worker received a one-time installation fee at the time of stove construction from both the government and the user. Future funding and targeted number of stoves were solely based on the numbers of stoves implemented in the past phase and *not* the numbers in use. This meant that in many areas the number of stoves disseminated exceeded demand while in others stoves were in short supply. The biogas project was similarly based on a very centralized structure. The entire program was dependent on government budget allocations and target oriented objectives. Assessments were not carried out to determine the number of plants to be installed. The annual targets were usually based on the achievements of the previous year and were not correlated with actual requirements. In addition, in an effort to meet these target numbers, the grassroots implementing organizations would often ignore other important program aspects like awareness raising, maintenance, training etc.

Increasing LPG Usage by Addressing Infrastructural and Cultural Issues and Perceptions

Consumption of LPG is still not high enough to improve indoor air quality. In fact, LPG is not used for day-to-day cooking purposes other than the monsoon season. Reasons for low usage could include the relatively high cost of installation and refill, unreliable refill services and the fact that biomass fuels will remain a cheaper alternative as long as they can be collected free of cost. Again, it is critical to disseminate health related information so that the households can make an 'informed' decision. In addition, a small proportion of the women perceived LPG as being 'unsafe'. This is a recurring issue with LPG adoption since it is easier to light an LPG stove compared to a biomass or kerosene stove. This is of particular concern for families with small children. Moreover, the gas is stored in the cylinders under pressure and this presents additional safety issues.

Helping the Poor Finance Biogas Plants

As mentioned earlier, the biogas project was highly subsidized by the Government of India. One of the main arguments for giving direct subsidies was to make biogas a feasible option for the economically and socially weaker section of the population. However, the requirements[72] for plant installation are such that the poor would not be able take advantage of this technology even with subsidies. Many studies have supported this fact. Subsidies were provided to the same extent in all areas, regardless of area specific demands and regional conditions like cold climates and drought prone areas.

Community gas plants, a concept introduced under the biogas project in the early 1980s, could increase biogas access to the poor households. There were several reasons why these gas plants were not successful[73]. These included i) the existing stratification (economic and religious) in the communities these plants were installed: affluent farmers usually had control over the resources (dung) for biogas production and many such households resorted to storing dung for making dung cakes in the event of short supplies of biogas; ii) management problems at local levels: in many villages the panchayats (village councils) took over after funding from the MNES ended. However,

[72] A biogas plant of 2 m^3 would require 4/5 cattle and limited access to water, land and cash

[73] Venkata R. Putti, "As if Institutions Matter: An Assessment of Renewable Energy Technologies in Rural India," Technology and Development Group, University of Twente, The Netherlands, 1998

they did not continue proper management practices and this led to irregular biogas production; iii) the amount of dung available was overestimated in many cases; and iv) the poor households were often unable to pay the installment costs ranging from Rs. 30 – 50[74] per month.

Despite these shortcomings, there were some success stories. For example, in the village of Methan in Gujarat where a uniform community[75] ensured that the community plant was running successfully and new initiatives like solar water pumping systems and women's associations were established as spin off activities. Other examples include cases where strong leadership has motivated the people to form cooperative societies (Kheri Bhai Ki Village in Punjab) or encouraged the local women to take up the management of these community plants (Motipura village, Gujarat). In addition to these factors, local entrepreneurs and/or NGOs can be encouraged to establish and manage these plants on a commercial basis with biogas having multiple uses such as for cooking, generating power and electricity supply.

Developing Low Cost, Regionally Suited Biogas Plants

There has been little effort in trying to develop low cost biogas plants. The Deenbandhu model was the only successful version. However it was developed through NGO collaborations. The biogas plants still depend on cow dung as its only source of organic matter. Considering that only 20% of rural households own cattle, more research needs to be conducted to find alternative sources of raw materials. In addition, wide geographical differences have given rise to plant design and maintenance issues. The northern and northeastern parts of India experience severe winters and biogas production goes down substantially during these times. This not only deters many families from adopting a plant but they also resort to using traditional stoves (burning traditional fuels) during those months of low gas supplies. In semi arid regions, many plants remain unused due to water shortages. More research needs to be conducted to develop biogas plants that suit region specific needs.

Providing Beneficiaries a Range of Clean Cooking Technologies

There is some indication that apart from households belonging to the scheduled castes and tribes, most of the other beneficiary households in the Deepam Scheme did not appear to be genuinely poor (living under the poverty line) although they had the white ration card. Providing beneficiaries a range of options may increase adoptions. If the ultimate aim is to shift households towards using a cleaner technology and/or fuel and improve health conditions then households should be given a range of technology and fuel to choose from. For example, households that cannot afford an LPG connection may opt for the improved stove. This initial step can go a long way in encouraging households to use cleaner fuels and technologies. Once this is achieved, further schemes and incentives can be adopted to move households up the 'energy ladder'. Improvements in local infrastructures are also required for successful interventions. Since the targeted beneficiaries are women, schemes could be developed to offer women income-generating activities (for example, existing micro-credit programs could be incorporated as an incentive measure) to increase the 'value' of the time saved from cooking, collecting and managing fuel.

[74] US$ 0.66 – 1.10 (US$ 1 = Rs. 45.36)
[75] Ismaili Muslims mainly practicing animal husbandry and are economically prosperous

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ANNEX A

A1 Differential in Health Status among States

Sector	Population Below the Poverty Line (%)	Infant Mortality Rate (1000 live births) [1999-SRS]	Under 5 Mortality (in 1000) [NFHS II]	Maternal Mortality Rate (in 100,000) [Annual Report 2000]	Leprosy cases (per 10000 population)	Malaria positive cases in 2000 (in thousands)
India	26.1	70	94.9	408	3.7	2200
Rural	27.09	75	103.7	-	-	-
Urban	23.62	44	63.1	-	-	-
Kerala	12.72	14	18.8	87	0.9	5.1
Maharashtra	25.02	48	58.1	135	3.1	138
Tamil Nadu	21.12	52	63.3	79	4.1	56
Orissa	47.15	97	104.4	498	7.05	483
Bihar	42.60	63	105.1	707	11.83	132
Rajasthan	15.28	81	114.9	607	0.8	53
Uttar Pradesh	31.15	84	122.5	707	4.3	99
Madhya Pradesh	37.43	90	137.6	498	3.83	528

ANNEX B

Important Maternal and Child Health Programs in India

National Tuberculosis Control Program

TB causes about 421,000 deaths in India every year. Since 1993, India had successfully implemented a TB control program using the World Health Organization's (WHO) DOTS[76] strategy. The program is implemented with assistance from the central government for supply of TB drugs, equipment etc. Proposed initiatives include opening more microscopy centers, DOTs and making provisions to reimburse the travel claims of patients and attendants for taking treatment at DOTs centers.

Neo-natal Tetanus Campaign

The Campaign aims to immunize all women of reproductive age with three doses of Tetanus Toxoid vaccine through a campaign approach. It was initiated in Rajasthan in 1998 and plans to immunize all married women till 30 years of age. There are plans to expand effort to several states.

Polio Eradication (Pulse Polio Immunization)

Launched in 1995, the program aims to administer oral polio drops to every child under 5 yrs (drops are given twice every year, in December and January, on the same day). The frequency of vaccine administration has increased from 2 to 4 in eight states. This includes immunization at fixed sites and house-to-house visits. Financial assistance is provided by external donors and World Bank loans.

Oral Rehydration Therapy for Children

The ORT program started in 1986/87 and aims to prevent diarrheal disease related deaths among children under five. The program is being implemented in a phased manner. The Government of India (GoI) is supplying ORS (Oral Rehydration Saline) packets, which is a part of a drug kit, to the states and all sub-centers in the country every year. ORS packets are marketed through Public Demonstration Days (ration shops). A national standard for the ORS packet has been developed and includes the logo, packet design and instructions for use on the ORS packet. The use of anti-diarrheal drugs are heavily discouraged (antibiotics are recommended in certain circumstances) and, the law prohibits the manufacture, sale and distribution of anti-diarrheal drugs. Adequate nutritional care of the child and proper advice to mothers on feeding are the two main focus areas of this program.

Prevention and Control of Vitamin A Deficiency

Under this program 5 doses of Vitamin A are administered to children under three. Doses are given at 9 months (with measles vaccine), 6 months thereafter with DPT/OPV booster doses and after another 6 months.

Essential Obstetric Care

Part of the Reproductive and Child Health program, EOC aims to provide basic maternity services to all pregnant women through: early registration of pregnancy (12-16 weeks), provision of at least 3 pre-natal

[76] DOTS is the internationally recommended TB control strategy and cover five elements: commitment, microscopy services, drug supplies, surveillance and monitoring systems, and use of highly efficacious regimes with direct observation of treatment.

check ups, safe delivery at home/institution, three post-natal cares and the provision of drug and contractual appointment of health personnel. In addition, staffs are given additional financial incentives to encourage round the clock delivery services at health centers. This ensures that at least one nurse/ medical officer/ janitor is available beyond regular working hours.

Emergency Obstetric Care (EOC)

This intervention is aimed at preventing maternal morbidity and mortality. The program was transferred from the Child Survival and Safe Motherhood Program (CSSM) to the Reproductive and Child Health (RCH) program and aims to strengthen Family Referral Units (FRUs) by supplying drugs (emergency obstetric drug kits), equipments kits and skilled manpower on a contractual/hiring basis. State specific proposals will be formed through a number of state level workshops. Due to the wide variety of home delivery practices by Traditional Birth Attendants (TBAs) or Dais the current RCH program aims to decentralize this activity by involving NGOs to make the intervention more area specific. NGOs will help to implement local pilot projects. Provisions have also been made to provide transportation to referral units for women who undergo deliveries at home but develop complications. This is mainly aimed at underprivileged families and the local panchayat[1] will be given adequate funding through the District Family Welfare Officers.

[1] Village council

ANNEX C

Information on Household Fuel Use in India

C1 Energy Use in India, by Sector

As can be seen from this table, the bulk of the energy for residential use comes from petroleum products (71%). However, energy use in the informal sector, which includes, household energy has not been addressed here. This table has been provided to give a general overview of energy used in the other sectors in the country.

Sector	Coal	Natural Gas	Petroleum Products	Power	Total
Agriculture	0	1.3	9.5	89.2	100.0
Industry	73.1	2.4	13.6	10.9	100.0
Transport	0	0	98.5	1.5	100.0
Residential	0	1.1	71.3	27.6	100.0
Others	0	33.9	60.9	5.2	100.0

Source: TERI estimates

C2 Energy Use in Six ESMAP Survey States, by Fuel Type (KgOE per Person per Month)

Average per capita energy use appears to be highest for fuelwood (27%) and one of the lowest for LPG. Himachal Pradesh, where LPG has been subsidized to protect forest resources, has one of the highest per capita use of the fuel (1%). However, this still constitutes a very small fraction of the total per capita consumption of LPG.

Fuel Type	Maharashtra	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

Source: Energy Strategies for Rural India: Evidence from Six States, UNDP/Word Bank Energy Sector Management Assistance Program (ESMAP), August 2002.

C3 Share of Each Fuel for Different End-use in Urban Households, India (in percent)

The table illustrates that LPG is the most commonly used fuel for cooking (47%). Fuels like firewood and dung are also used, typically in slums in the urban periphery where infrastructure and access to LPG may be limited. Only electricity is used in greater proportions for purposes other than cooking.

Fuel	Cooking	Water Heating	Lighting	Space Heating	Space Cooling	Others
LPG	47.1	11.6				
Kerosene	12.6	23.2	7.9			
Soft Coke	5.0	3.3				
Firewood	31.6	33.9				
Dung	3.2	4.5				
Electricity	0.5	23.5	92.1	100	100	100
Total	100	100	100	100	100	100

Source: TERI (1995)

C4 Share of End-use in Urban Households Fuel Consumption, India (in percent)

Over 70% of each fuel type is used for cooking activities in urban households. Tthis is closely followed by water heating (which is also used for cooking).

Fuel	Cooking	Water Heating	Lighting	Space Heating	Space Cooling	Others	Total
LPG	96.3	3.7					100
Kerosene	71.2	20.6	8.2				100
Soft Coke	90.9	9.2					100
Firewood	85.6	14.4					100
Dung	82.1	17.9					100
Electricity	1.0	7.6	34.7	25.3	3.8	27.6	100

Source: TERI (1995)

C5 Time and Effort Involved in Fuelwood Collection in Rajasthan (% of household)

The majority of the households appeared to walk about 1-2 km for fuelwood collection. This amounts to almost 50 hours spent collecting fuel every month. The burden of fuelwood collection (for short distances) usually falls on women and small children (especially girls) and this can have adverse impacts in the areas of health and girl's education.

Type of Effort to Collect Fuel Wood		**All**
Distance walked to collect fuelwood	Up to 1 km	29
	1-2 km	30
	2-3 km	23
	More than 3 km	18
Avg. time spent per trip (hours)		3.2
Avg. number of trips per Hh per month		15.6
Avg. time spent per month per Hh		49.9
Base: Hhs always/mostly gathering fuelwood		1,483

Source: Laxmi, V., et al., "Household Energy, Women's Hardship and Health Impacts in Rural Rajasthan, India: Need for Sustainable Energy Solutions," Energy for Sustainable Development, March 2003:6(1).

C6 Family Time Spent Collecting Fuelwood in India, 1996

The table indicated that lower income groups travel longer distances and spend more time collecting fuelwood. However, it appears that more children in higher income groups participate in fuel collection than the lower income groups (8% for income decile less that 575; 19% of children for income decile 1,1416 – 1,740). This could be because more affluent families travel shorter distances and therefore can take their children along. Participation did not vary greatly by family income levels and surprisingly men's participation was consistently higher than women. Whereas lower income families travel longer distances and are therefore accompanied by men, higher income families may travel relatively shorter distance by bullock carts, which are usually driven by men.

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	37.0	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.

C7 Percent of Households that own Rural Energy Devices, 1996

The improved chulhas appear to be the most prevalent rural energy device with the State of Rajasthan having the highest numbers (20%). This could be due to the commercialization approach adopted by the state. Biogas plants though not as abundant are found in the highest numbers in Andhra Pradesh (8%). Other energy devices do not appear in significant numbers although pressure cookers, probably locally manufactured and cost effective, are quite popular in Punjab and Rajasthan.

Appliance	Andhra Pradesh	Himachal Pradesh	Maharashtra	Punjab	Rajasthan	West Bengal
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

ANNEX D

Information on Stove, Biogas and LPG Programs

D1 Overview of National Program on Improved Cookstoves in Six States

State	Type of fixed type mud stove frequently in use (Name of model)	Average stove efficiency (%)	Number of stoves installed in the state (1999-2000)	Cumulative total number of improved stoves installed (1995-2000)
Andhra Pradesh	2 pot with chimney; pottery liners (Sukhad) 2 pot chimney; pottery liners (Gayathri)	20-28	186,000	1,259,892
West Bengal	1 pot with chimney (Sohini Seva) 1 pot coal with chimney (Kalyani) 2 pot with chimney (Sugam Seva)	18 22-40 22	497,589	2,093,735
Haryana	1 pot with chimney (Mohini) 2 pot with chimney (Jaitan and Akash)	23 22	55,000	236,970
Maharashtra	1 pot with chimney (Grihalaxmi) 2 pot with chimney (Laxmi) 2 pot without chimney (Parvati and Bhagyalaxmi)	24-28	95,103	788,189
Gujarat	2 pot with chimney (Mamta) 1 pot with chimney (Sneha)	24	99,885	397,785
Karnataka	2 pot with chimney; pottery liners (Sukhad) 2 pot with chimney; pottery liners and mould (Sarale Ole)	20-29	59,033	438,785

Source: Douglas Barnes and Priti Kumar, "Success Factors in Improved Stove Programs: Lessons Learned from Six States in India", Paper to be published in Journal of Environmental Studies and Policy, TERI, India.

D2 List of Technical Backup Units Set-up under the Stove Program

	Technical Backup Units
1.	Department of Mechanical Engineering, Regional Engineering College, Warrangal, (A.P.- 506 004)
2.	Assam Science, Technology and Environment Council, Panchwati, Silpukhri, Guwahati.
3.	Punjab Energy Research Centre, Punjab University, Chandigarh – 160 014
4.	Karnataka State Council for Science and Technology, Indian Institute of Science, Bangalore – 560 012
5.	College of Engineering, Thiruvananthapuram, Kerala
6.	M. S. University Varodara
7.	Centre of Energy Studies and Research, Devi Ahilya Vishwavidyalaya, Khandwa Road Campus, Indore - 452 001
8.	Regional Research Laboratory, Bhubaneshwar - 751 013
9.	Thapar Polytechnic, Patiala – 147 001
10.	College of Technology and Agricultural Engineering, Rajasthan Agricultural University, Udaipur - 313 001
11.	College of Agricultural Engineering, Tamil Nadu, Coimbatore – 641 003
12.	Department of Chemistry, University of Kalyani, District Nadia, West Bengal – 741235.
13.	Appropriate Rural Technology Institute, 6, Koyna Apartments, Kothrud, Pune – 411029.
14.	Dr. Yashwant Singh Parmar University of Horticulture & Forestry, Directorate of Extention Education, Solan - 173230 Himachal Pradesh

Source: Technical Backup Unites set up under NPIC, National Program on Improved Chulhas (NPIC), Ministry of Non-Conventional Energy Sources, <http://mnes.nic.in/frame.htm?majorprog.htm>

D3 State-wise List of Nodal Agencies/Departments for Implementation of Governmental Stove and Biogas Programs in India

Andhra Pradesh Managing Director Non-Conventional Energy Development Corporation of Andhra Pradesh 5-8-207/2, Pisgah Complex Hyderabad – 500 001	Arunachal Pradesh Director Arunachal Pradesh Energy Development Agency Post Box No. 141 Itanagar - 791 111.
Assam Director Directorate of Panchayat & Rural Development, Govt. of Assam Sethi Bhavan, 7th Floor, G.S. Road, Bhangagarh Road Guwahati – 781 005.	Bihar Director Bihar Renewable Energy Development Agency Lal Kothi, Shikarpur House Dr. T.N. Banerjee Road Chaju Bagh, Patna - 800 001.
Chhattisgarh Director Chhattisgarh State Renewable Energy Development Agency (CREDA) Government of Chhattisgarh Department of Energy 181, D.K.S. Bhawan, Mantralaya Raipur – 492 001 .	Gujarat Managing Director Gujarat Agro Industries Corporation Ltd., Khet Udyog Bhavan, Opp. High Court Ahmedabad – 14.
Goa Director Directorate of Agriculture Govt. of Goa Vidyut Bhawan, Panaji Goa.	Haryana Joint Director (Agril. Engg.) Directorate of Agriculture SCO 4, Sector 17-E Government of Haryana Chandigarh 160 017.
Himachal Pradesh Director of Agriculture Directorate of Agriculture Government of Himachal Pradesh Nalagarh House Shimla – 5	Jammu & Kashmir Director Jammu & Kashmir Energy Development Agency Dept. Of Science & Technology Directorate of Jammu & Kashmir Jammu – 180 001.
Karnataka Director (REP) Rural Development & Panchayati Raj Department, Government of Karnataka Multi Storey Building, III Stage - III Floor, Bangalore- 560001	Kerala Secretary Government of Kerala Department of Agriculture Secretariat Thiruvananthapuram.

Madhya Pradesh Managing Director Madhya Pradesh State Agro Industries Development Corporation Ltd. Panchanan, 3rd Floor, Malviya Nagar Bhopal – 462 003. Managing Director Madhya Pradesh Urja Vikas Nigam Ltd. Urja Bhawan, Main Road No.2 Shivaji Nagar, Bhopal – 462 016.	Maharashtra Secretary Rural Development and Water Conservation Department Government of Maharashtra Mantralaya, Mumbai – 400 032. Meghalaya Director-Cum-Member Secretary Meghalaya Non-Conventional & Rural Energy Development Agency (MNREDA) Near BSF Camp (Mawpat) P.O. Nongmynsong, Shillong – 793 011.
Manipur Director Manipur Renewable Energy Development Agency Governor Road Imphal – 795 001.	Mizoram Secretary Animal Husbandry and Veterinary Department Government of Mizoram Aizwal.
Nagaland Director Directorate of Rural Development Government of Nagaland Kohima. - 797 001 .	Orissa Chief Executive Officer Orissa Renewable Energy Development Agency S/59, Mancheswar Industrial Estate Bhubaneswar – 751 010
Punjab Director, Agriculture (Punjab) Department of Agriculture, Punjab Government of Punjab S.C.O. 85-88, Sec. 34-A	Rajasthan Secretary Rural Development Department Government of Rajasthan Secretariat Jaipur.
Chandigarh Chief Executive Punjab Energy Development Agency S.C.O. 54-56, Sector-17-A Chandigarh-160 017	Sikkim Director Sikkim Renewable Energy Development Agency Tashiling Secretariat, Annexure-II Gangtok – 737 101.
Tamilnadu Secretary Department of Rural Development Government of Tamilnadu Fort St. George Chennai – 600 008.	Tripura Director Tripura Renewable Energy Development Agency Bijnam Bhavan, 2nd Floor Gorkhabasti, A.R. Complex Agartala – 799 006 .
Uttar Pradesh Commissioner Rural Development Department (U.P.) Government of Uttar Pradesh Jawahar Bhavan, 10th Floor Lucknow - 226 001 .	Uttaranchal Principal Secretary & Commissioner Forest & Rural Development Branch Government of Uttaranchal Dehradun.

West Bengal Director West Bengal Renewable Energy Development Agency Bikalpa Shakti Bhavan J1/10, EP&GP Block, Sector-V Salt Lake Electronics Complex Kolkata - 700 091 .	Jharkand Secretary-cum- Chairman Jharkhand Renewable Energy Development Agency Ashok Nagar, Road No.4 Vidhyalaya marg Ranchi.
Other implementing agencies	
Chairman Sustainable Development Agency MDS Training Centre, Parathodu – 686 512 Kanjirapally	
Chief Executive Officer Khadi & Village Industries Commission `Gramodaya', 3, Irla Road, Vile Parle(W) Mumbai - 400 056.	

D4 State-wise Installation of Household Biogas Plants, March 2003

State/UT	Estimated potential	Number of Biogas Plants installed	Percentage coverage of potential
Andhra Pradesh	1065600	354334	33
Arunachal Pradesh	7500	1721	23
Assam	307500	53769	17
Bihar	939900	123963	13
Goa	8000	3428	43
Gujarat	554000	359047	65
Haryana	300000	45414	15
Himachal Pradesh	125600	44194	35
Jammu & Kashmir	128500	2013	2
Karnataka	680000	365243	54
Kerala	150500	90823	60
Madhya Pradesh	1491200	216970	15
Maharashtra	897000	687657	77
Manipur	38700	2026	5
Meghalaya	24000	2671	11
Mizoram	3000	3015	94
Nagaland	6700	1792	27
Orissa	605000	198692	33
Punjab	411600	72279	18
Rajasthan	915300	66735	7
Sikkim	7300	4125	57
Tamilnadu	615800	203808	33
Tripura	28500	2069	7
Uttar Pradesh	2021000	382784	19
West Bengal	695000	220969	32
A & N Islands	2200	137	6
Chandigarh	1400	97	7
Dadra & Nagar Haveli	2000	169	8
Delhi	12900	676	5
Pondicherry	4300	573	13
Chattisgarh	*	8078	-
Jharkhand	*	925	-
Uttaranchal	*	2912	-
TOTAL :	12049900	3523108	29

* Included in respective parent state

Source: National Project on Biogas Development, Ministry of Non-Conventional Energy Sources. < http://mnes.nic.in/frame.htm?majorprog.htm>

D5 Models of biogas plants under the Biogas Project (NPBD)

Model	**Approved capacity** (cubic metres gas production per day)
Floating Drum Type Biogas Plant - KVIC Model	1 to 10
KVIC Model with ferro cement digester and / or fibre glass reinforced plastic (FRP) gas holders	1 to 10
Deenbandhu Model	1 to 6
Deenbandhu in-situ model with ferro-cement	1 to 6
Pragati Model	1 to 6
Bag digester made of rubberized nylon fabric - Flxi model	1 to 6

Source: National Project on Biogas Development, Ministry of Non-Conventional Energy Sources.
< http://mnes.nic.in/frame.htm?majorprog.htm>

D6 Statewide Allotment and Release of LPG Connections under the Deepam Scheme in Andhra Pradesh (as of September 2001)

District	Beneficiaries Selected	1st Allotment	1st Release	2nd Allotment	2nd Release	Total Allotment	Total Releases
Srikakulam	40253	28165	29347	7035	5905	35200	35252
Vizianagaram	36110	29862	28427	6014	5936	35876	34363
Vishakhapatnam	61391	28553	23767	23748	21550	52301	45317
East Godavari	69858	41185	42226	22990	19799	64175	62025
West Godavari	58040	38868	36504	12660	10011	51528	46515
Krishna	61038	41606	43562	29772	26959	71378	70521
Guntur	70123	42334	39865	27389	27888	69723	67753
Prakasam	50542	38647	33062	15435	8810	54082	41872
Nellore	50574	32241	28079	18690	13124	50931	41203
Chittoor	56049	43523	42254	17685	11451	61208	53705
Cuddapah	45052	25322	22202	20789	8795	46111	30997
Ananthapur	84878	34497	32602	28278	21498	62775	54100
Kurnool	48138	29524	28995	22792	20133	52316	49128
Mahabubnagar	104638	37918	37424	28992	11438	66910	48862
Ranga Reddy	49297	24822	27734	18929	12524	43751	40258
Medak	53322	33201	31389	8280	5925	41481	37314
Nizamabad	40916	25244	30688	9023	9845	34267	40533
Adilabad	66376	32801	42611	13401	12820	46202	55431
Karimnagar	59984	42024	39994	9309	8916	51333	48910
Warangal	62765	41906	42457	18657	11064	60563	53521
Khammam	55264	28082	20721	15239	11544	43321	32265
Nalgonda	72460	39056	38067	19893	11979	58949	50046
Total	1313014	759381	741977	395000	297914	1154381	1039891

Source: Deepam Scheme, Food, Civil Supplies and Consumer Affairs Department, Government of Andhra Pradesh <http://www.ap.nic.in/dwcra/DEEPAM_CIVILDEPTSTMT.htm>

ANNEX E

Contact Information for Key Actors in Household Energy

E1 Key Actors in Household Energy

Ministry of Non-Conventional Energy Sources Secretary Ministry of Non-Conventional Energy Sources, Block-14, CGO Complex, Lodhi Road, New Delhi-110 003, India. Tel: 91-11-2436-1481, 2436-2772 Fax: 91-11-436-2772 E-mail: secymnes@hub.nic.in Website: http://mnes.nic.in/	Planning Commission Secretary Planning Commission Tel: 91-11-2309-6574 Ext. 2270 Fax: 91-11-2309-6575 Website: http://planningcommission.nic.in/
Ministry of Petroleum and Natural Gas Union Minister of Petroleum & Natural Gas Government of India New Delhi – 110 001 Tel: 91-11-2338-6622, 91-11-2338-1462 Fax: 91-11-2338-6118 E-mail: mopng.png@sb.nic.in Minister of State Petroleum & Natural Gas Government of India Shastri Bhawan New Delhi - 110 001 Tel: 91-11-2338-5823, 01-11-2338-4082 Fax: 91-11-2307-3167	**World Bank** Geetanjali Chopra The World Bank Office-New Delhi 70 Lodi Estate, New Delhi 110 003 Telephone: (91-11) 4617241 Fax: 91-11-4619-393 E-mail: gchopra@worldbank.org Website: http://www.worldbank.org.in/ In Washington: Karina Manasseh Tel: (202) 473-1729 Fax: (202) 522-0321 E-mail: kmanasseh@worldbank.org
Ministry of Environment and Forests The Secretary Government of India Ministry of Environment & Forests Paryavaran Bhavan CGO Complex, Lodhi Road New Delhi - 110 003, (INDIA). Tel: 91-11-2436-1896, 2436-0721 E-mail: secy@menf.delhi.nic.in	Appropriate Rural Technology Institute (ARTI) Dr. A. D. Karve Appropriate Rural Technology Institute [ARTI] 2nd Floor, Maninee Apartments, S.No.13, Dhayarigaon, Pune 411 041, India. Tel: 91-212-439-0348, 439-2284 E-mail: adkarve@pn2.vsnl.net.in
Development Alternatives Group B-32, Tara Crescent Qutab Institutional Area New Delhi - 110016 Tel: 91-11-2685-1158, 2696-7938 Fax : 91-11-2686-6031 E-mail : tara@sdalt.ernet.in Website: http://www.devalt.org/	The Energy research Institute (TERI) Darbari Seth Block Habitat Place Lodhi Road New Delhi - 110 003. India Tel: 91-11-2468-2100, 2468-2111 Fax: 91-11-2468-2144, 2468-2145 Website: http://www.teriin.org/

Winrock International India 1, Navjeevan Vihar New Delhi - 110017 Tel: 91-11-2669-3868 Fax: 91-11-2669-3881 E-mail: winrockindia@winrockindia.org Website: http://www.winrockindia.org/index.htm	

Source: Nodal departments and nodal agencies for implementation of Rural Energy Programs, Department of Non Conventional Energy Sources <http://mnes.nic.in/frame.htm?majorprog.htm>

E2 Key Actors in Health

Ministry of Health and Family Welfare Maulana Azad Road New Delhi - 110011 Ministerial Contacts: Mrs. Sushma Swaraj Union Minister for Health & Family Welfare E-mail: swaraj@sansad.nic.in Tel: 91-11-23014647, 23014751, and 23010661 Fax: 91-11-23016648 Dr. Vallabhbhai Kathiria Minister Of State for Health & Family Welfare E-mail: vrkathiria@hub.nic.in Tel: 91-11-23018157, 23014016, and 23016551 Fax: 91-11-23018157	World Vision, India Pariwar Soc, Ground Floor Gala No 6 5 Dadabhai Rd, Andheri (W) Bombay 400 058 India Tel: 91-11-22 625 1293 Fax: 91-11-22 621 1658
Department of Women and Child Development Jaskaur Meena Minister of State E-mail: mos.wcd@sb.nic.in Tel: 91-11-23074052, 23074053 Fax: 91-11-23074054	World Health Organization (WHO) The WHO Representative Office of the WHO Representative India Rooms 533-535, 'A' Wing Nirman Bhawan Maulana Azad Road New Delhi 110011
United Nations Children's Fund (UNICEF) – New Delhi Office 73 Lodi Estate New Delhi 110 003 India E-mail: newdelhi@unicef.org Tel: 91-11-2469.0401, 2469.1410 Fax: 91-11-2462.7521	Gram Vikas Sojan K Thomas Manager, RHEP Mohuda Village Berhampur 760 002, Ganjam, Orissa, India. Tel: 91-680-2261863 to 2261874 Fax: 91-680-2261862 Email: info@gramvikas.org

Aga Khan Foundation Mr. Robert D'Arcy Shaw Aga Khan Foundation Place des Eaux-Vives 6, CH-1207 Geneva, Switzerland Tel: 41-22-736 92 95 Fax: 41-22-736 80 60	Ministry of Rural Development Shri Kashiram Rana Minister for Rural Development Krishi Bhavan Dr. Rajendra Prasad Road-1 New Delhi, India Tel: 91-11-23782327 / 23793824 Fax: 91-11-23385876 E-mail: krana@sansad.nic.in