N A T U R A L   R E S O U R C E S   I N S T I T U T E

Energy Efficiency and Poverty Alleviation

Final Report

SUB-SECTOR: ENERGY

PROJECT NO: R7222

Natural Resources Institute

DFID Department for International Development

Energy Efficiency and Poverty Alleviation

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EXECUTIVE SUMMARY

Project Purpose: The 1997 UK Government White Paper on International Development commits the Department for International Development (DFID) to the 'elimination of poverty and encouragement of economic growth which benefits the poor' and to promoting 'sustainable livelihoods. Departments within DFID are trying to establish what this means for their policy. This project is funded by the Energy Sub-sector, DFID- UK. It seeks to identify activities and sectors where improved energy efficiency could have direct environmental and socio-economic gains for the poor. The overall aim is to inform policy making in the energy sector.

Energy-poverty links: Understanding the links between energy efficiency and poverty is central to this study. The integrated development recognises the complex nature of environment-poverty links. It is within this holistic analytical framework that poverty is defined. Here poverty is seen as a multi-dimensional problem where one of the determinants of well-being is the physical environment. The quality of this environment depends on the presence of pollutants and pathogens in air, water and soil. Among the range of factors affecting the environment, combustion is one of the potential sources of air pollution. Inefficient energy use combined with poor work practice can be deleterious. It is therefore argued that, targeting assistance to enhance efficiency of fuel use in those sectors and activities which directly affect the urban poor, could improve the physical environment and generate benefits for the poor in terms of improved health, greater earning capacity and increased disposable income. Additionally, enhanced efficiency would mean higher returns to inputs and reduced pollution load for industry.

The objectives of this report are to

- contextualise the research problem with reference to poverty, air pollution and energy use;
- based on secondary data search and in-country research, identify those activities and sub-sectors in industry, commerce and domestic sectors, where interventions could generate direct benefits for the urban poor;
- identify energy intensive activities within these sub-sectors, as one of the main objectives of the Energy Sub-sector, DFID, is to target energy intensive activities;
- assess the scope, benefits and constraints for targeting assistance; and
- make recommendations based on these findings.

The methodology: The study first undertook a desk review to explore the links between energy use, environment and poverty at city, sectoral and household levels. A review of energy use and poverty links in industry, commerce and households in Asian and African countries was also undertaken. Given the time constraints and the expertise of the study team, India was selected for in-depth case study. Once India was selected for case-study, the first activity was to obtain national aggregated data for energy use in industry, commerce and for household use as cooking fuel. These areas of energy use were then reviewed to identify any links that exist between energy efficiency and poverty. Stronger energy use-pollution-poverty linkages were noted in industrial and domestic sectors. The scope for efficiency improvements was noted in the commercial sector, but it was difficult to establish energy-poverty linkages, given the database.

Based on the data available, industrial and domestic sectors were taken up for detailed analysis. This examination showed that targeting assistance to small industries would have greater poverty impacts and also benefit industry. For the domestic sector, the review indicated that it would be more appropriate to focus on urban household where enhanced efficiency could have measurable poverty impacts. These issues were further investigated, while in the UK and then in India.

In New Delhi and Calcutta, India, wide ranging discussions were undertaken with different organisations, experts and practitioners to obtain views on the research problem, on the provisional findings of this study and to assess recent developments and initiatives to enhance energy efficiency in industrial and domestic sectors and in environmental management.

The main findings of this study are:

Domestic Sector

Applicable to developing countries in general

1. Benefits of enhanced energy efficiency at the household level could be in terms of increased disposable income and improved health following reduction in pollution. Therefore, measures of poverty impact could be savings in fuel bills; proportionate share of uptake by poor households; proportion of improved stoves in use after measuring drop-out rate; and range of expected benefits generated, as defined by the target group.

2. There are two main management options for enhancing energy efficiency in household fuel use. These are: A. Improved stoves; and B: Fuel Switching- Moving Up the Energy Ladder.

3. Enhanced efficiency leading to reduced fuel needs will reduce the mass of pollutants generated. This will have health impact if cooking is undertaken indoors.

4. There has to be careful evaluation at project design stage of levels of economic benefits that could accrue in terms of disposable income from enhanced energy efficiency.

5. It is important to define minimum exposure limits before judgement can be made if improved stoves do really do reduce health risks posed by PAH class of compounds.

6. Energy is an issue, though not a priority, for poor people in urban areas.

Specific to India

7. The bulk of the urban poor in major cities of India appear to have made a shift up the energy ladder from biomass fuel to kerosene.

8. The shift from biomass to kerosene has moved cooking indoors increasing the environmental health risks for women and children of indoor pollution.

9. Kerosene users need to be targeted through health programmes and to increase their awareness of dangers of using kerosene in a poorly ventilated rooms.

10. There may be limited opportunities for improving efficiency of energy use, other than assisting households to move up the energy ladder, in the big cities. In towns, small cities and peri-urban

areas there may be more interest in investing in an improved wood-burning *chulha*, though possibly from an improved health perspective than from potential energy savings.

11. Woodfuel users are the poorest in urban areas, often transient/new arrivals. They are difficult to target. Many will probably eventually switch to kerosene (due to opportunity cost of woodfuel collection; peer pressure, safety aspects). This implies a need to examine opportunity for supporting improved *Chulha* programme in appropriate areas.

12. There is need to put energy on the urban planning agenda. At present it has no place in urban management in India.

Industrial Sector

Applicable to cities in developing countries

1. Given the aim and objectives of this study, assistance to large scale industries cannot be justified.

2. In the context of small scale sector in developing countries, initiatives targeting only combustion related pollution will have little impact on overall air pollution and therefore have no impact on poverty.

3. Energy-led initiatives in small scale industries with the scope to address other sources of pollution, leading to environmental improvements could reduce intra-urban differentiation in pollution impact and generate benefits for the poor.

4. Pollution control and energy efficiency in small industries cannot be expected to follow from simply superimposing models that have been used for large industries. These operations are still essentially rooted in a socio-economic culture that has largely been displaced in developed countries.

5. There is need for flexible, sub-sector approach to the environmental management in small industries.

6. The people who participate in the manufacturing sector are not the ‘poorest of the poor’ but the workers in the small scale sector constitute an extremely vulnerable segment of the society. Insecurity of job tenure, appalling working conditions and threat of closure and loss of livelihood make them an important target group.

7. Communities of low income housing with low levels of empowerment but subject to high levels of industrial pollution form an equally important target group.

8. It is important to develop strategies that lessen pollution control costs and also reduce manufacturing costs. It is crucial to inform industry of economic gains that could be made in terms of increased efficiency, higher material recovery and lower waste generation from technological upgradation and process improvements.

Specific to India

9. The clustering tendency of small industries in India provides clearly identifiable spatial units for poverty-environment initiatives.

10. Research gap in poverty-environment analysis has been identified by this study. Though there is a general consensus that poor live close to polluted areas and suffer disproportionately, no socio-economic-environmental research has been conducted in India to establish the affects/associations of cluster based pollution.

1 The importance of targeting inefficiencies in energy intensive sub-sectors of small scale industries has been recognised in India. Several national agencies, funded by international lending agencies (World Bank and Swiss Agency for Development and Co-operation) are already active in this field.

2 None of the environmental programmes examined by this study have a poverty dimension.

1. Energy intensive sub-sectors in small scale industries identified in India are
Foundries producing castings and forging
Glass industry
Manufacture of edible oils and fats
Small Scale Bakery Units
Small Scale Steel Re-rolling Units
Small Scale Plastic Processing Units
Small Scale Glass Production.
Small Scale Ceramic Tableware Units

14. There is no formal institutional framework which brings together the specialised agencies, the government departments and semi-autonomous agencies which are all individually involved with small scale industries. There is need to raise awareness at the institutional level.

15. There are several research and technical agencies in India. There is scope for enhancing capability in these organisations to enable them to contribute to environmental improvements in small scale industrial sector.

Recommended Approaches To Energy Efficiency Initiatives (Chapter 13).

Domestic Sector

Specific to urban India

1. Target kerosene users through health programmes to increase awareness of dangers of using kerosene in a poorly ventilated room.

2. Explore potential for low-cost design improvement of kerosene stoves using modern, but affordable material, to ensure better combustion.

Applicable in other developing countries and India

3. Examine opportunities for supporting improved stove programme in appropriate areas.

4. Assist to define minimum exposure limits so that judgement can be made if improved stoves do really reduce the health risks posed by PAH class of compounds.

5. Put domestic energy demand management on urban planning and management agenda.

Industrial Sector

The study indicates that the recommendation made below have applicability in Indian and other Asian cities. It is expected that environmental improvements in small industries (given their employment and polluting potential) will become an important component of overall urban environmental management.

1. Target inefficiencies in clusters of small scale industries to generate benefits for a large group of urban poor.

2. Disseminate information on benefits which can accrue to industry from enhanced efficiency of fuel and resource use.

3. An energy led initiative where the core objective is to enhance energy efficiency but with the scope to address other related sources of air pollution so as to generate maximum benefits for the poor.

4. Target the large number of vulnerable low income workers in small industries and those living adjacent to highly polluting clusters of industries.

5. Any energy led initiative in small scale industries should incorporate the lessons learnt from other on-going programmes.

6. Facilitate the development of a participatory approach to enhancing efficiencies in energy and resource use as it has more scope for success.

7. Assist in institutional awareness raising and capability building.

8. Assist in developing an appropriate institutional framework which can incorporate the flexibility of a participatory approach to environmental improvements.

These recommendations imply that DFID as an organisation can act at either one or at two levels. These are, one, at cluster level for example, to help develop procedures/methodologies for participatory environmental improvements in energy intensive sub-sectors; and two, at the sectoral level to assist in institution and capability building.

Commercial Sector

1. Need for a systematic study and greater understanding to identify poverty links.

Influencing Policy

1. Put demand management of energy on the agenda.
Demand management is a neglected policy area in India. Assist to develop a demand management strategy at the national level to rationalise and plan fuel use.

2. Put energy on the agenda of urban development programmes
Urban domestic fuel use is a neglected issue. DFID could assist in the establishment of energy task-force, with national and state governments, NGOs, research organisations and slum improvement boards. Liase with other DFID-supported initiatives. Energy task force could inform DFID health groups of impacts of indoor pollution.

Lessons For Participatory Environmental Initiatives

The experience of projects targeting inefficiencies of energy and resource use have important lessons for a participatory approach to environmental problems. These are detailed in Section 13.3, page 103.

Future Research Needs

1. Study on poverty impact of reduction in subsidy on kerosene:
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2. Study to assess impact of reduction of cluster based pollution on low income workers and residents.

3. Systematic scoping study to assess the need for an improved stoves programme in India.

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PART I

SETTING THE CONTEXT

1. INTRODUCTION

1.1 Project Purpose

1.1.1 This is the final report of the project titled: Energy Efficiency and Poverty Alleviation. The project is funded by the Energy Sub-sector, Department For International Development, UK. It seeks to identify activities and sectors where improved energy efficiency could have direct environmental and socio-economic gains for the poor. The overall aim is to change policy making in the energy sector.

1.2 Background

1.2.1 The 1997 UK Government White Paper on International Development commits the Department for International Development (DFID) to the ‘elimination of poverty and encouragement of economic growth which benefits the poor’ and to promoting ‘sustainable livelihoods”. All departments within DFID are trying to establish what this means for their policy. The aim of this study, undertaken for the Energy Sub-sector, is to establish if enhanced energy efficiency in certain sectors and activities could generate benefits for the poor. If so, what are these activities and sub-sectors, what are their poverty links and where should assistance be targeted.

1.2.2 At the core of this analysis is the evidence that the growing number of poor in urban and peri-urban areas suffer a disproportionately high impact of pollution.(Hardoy & Satterthwaite: 1992; Bradley et al: 1992). There is evidence that this intra-urban differentiation in pollution impact is due to the spatial juxtaposition of industrial and low income housing. Additionally, low income workers in small industrial units are subject to high levels of workplace pollution due to energy and process inefficiencies (Kothari: 1983: Kogi: 1985; Thomas: 1991; Dasgupta: 1997). The impact of air pollution on health and consequently on earning capacity is well documented (Hardoy & Satterthwaite: 1989; Bradley et al: 1992; Pryer: 1993; Surjadi:1995). Moreover, in some Asian countries (Bangkok- Lohwongwatana: 1990; Hong Kong- Lin: 1994; Delhi- Dasgupta: 1998;) the more stringent environmental enforcement in recent years is threatening small polluting units with closure, jeopardising the livelihood of low income workers.

1.2.3 Analysis of energy statistics show that (i) energy use increases as development progresses; and (ii) limited examples of accurate measurements indicate gross inefficiencies in industry and in use in the domestic sector. Research (TERI: 1998; Smith: forthcoming) shows that high levels of indoor pollution is associated with inefficient domestic fuels and stoves. The impact of indoor pollution is biased in that it affects women, children and old people more than the men in the households.

1.2.4 Establishing the link between enhanced energy efficiency and poverty is central to this project. Here poverty is seen as a multi-dimensional problem where one of the determinants of well-being is the physical environment. The quality of this environment depends on the presence of pollutants and pathogens in air, water and soil. Among the range of factors affecting the environment, combustion is one of the potential sources of air pollution. Inefficient energy use combined with poor work practice can be deleterious. It is therefore argued that, targeting assistance to enhance efficiency of fuel use in those sectors and activities which directly affect the urban poor, could improve the physical environment and generate benefits for the poor in terms of improved health and greater earning capacity. Additionally, enhanced efficiency implies higher returns to industry from inputs; lower levels of pollution; reduced threat of closure and greater security of livelihood for the workers.

1.3 Objectives of the Report

1.3.1 The objectives are to

- contextualise the research problem with reference to poverty, air pollution and energy use;
- based on secondary data search and in-country research, identify those activities and sub-sectors in industry, commerce and domestic sectors, where interventions could generate direct benefits for the urban poor;
- identify energy intensive activities within these sub-sectors, as one of the main objectives of the Energy Sub-sector, DFID, is to target energy intensive activities;
- assess the scope, benefits and constraints for targeting assistance; and
- make recommendations based on these findings.

1.4 Methodology

1.4.1 The study first undertook a desk review to explore the links between energy use, environment and poverty at city, sectoral and household levels. The city level review showed that there was considerable intra-urban differentiation in pollution impact in most cities of developing economies. This differentiation is attributed to the fact that industries and low income housing seek out low cost land. There is little evidence to report on this kind of disparity in the rural areas. Hence, the focus on urban industries.

1.4.2 An review of energy use and poverty links in industry, commerce and households in Asian and African countries was undertaken. Given the time constraints and the expertise of the study team, India was selected for in-depth case study. A comparative analysis of India and China would have been useful. Most official information in China is published in Chinese. However, attempts have been made to draw on whatever information was accessible.

1.4.3 The next activity was to obtain national aggregated data for energy use in industry, commerce and for household use as cooking fuel, in India. These areas of energy use were then reviewed to identify any links that exist between energy efficiency and poverty. Stronger energy use-pollution-poverty linkages were noted in industrial and domestic sectors. The scope for efficiency improvements was noted in the commercial sector, but it was difficult to establish energy-poverty linkages, given the database. The DFID-funded programme, 'Development of Commercial Energy Efficient Cooking' (R6848), in Africa was then examined to assess the impact on low income groups. The programme's target group was stoves producers and target sectors were hospitals, schools and other large government institutions. The programme appears to have had some success in the dissemination of improved commercial stoves, it had little or no impact on the poor. Hardly any new jobs had been created and beneficiaries of improved stoves were medium sized organisations. Whether the gains made through reduced fuel use were being ploughed back to benefit the poor is difficult to say.

1.4.4 Based on the data available for India, industrial and domestic sectors were taken up for detailed analysis. This examination threw up potential industrial sub-sectors and issues in domestic fuel use which were further investigated, while in the UK and then in India. The initial review of energy issues relating to large scale industries showed little justification for assistance as they possessed the financial and technical resources to enhance efficiencies. Thus, the study focused on small scale industries. The initial review of domestic sector programmes led the study to focus on issues of improved stoves in urban areas. There are three factors:

1.4.5 (i) the review of improved stove programmes in developing countries showed that considerable knowledge and expertise existed with regards to stove programmes in rural areas. There was very limited information on urban stove programmes; (ii) the review of Rural Energy Security (DFID projects: ZF0021 and R6297) showed that most rural households collect fuelwood for free so there is little incentive to invest in stoves. On the other hand, in “urban areas where people buy fuel there is a clear incentive to invest in fuel saving technology” (pp. 13). This implied that urban household could make financial gains from enhanced efficiency leading to reduced fuel use; and (iii) most stove programmes have their origins in ‘woodfuel gap theory’ which predicted fuelwood crises. The objectives of this study reflects the shift to poverty issues within the ‘livelihoods approaches’. It was thus, considered appropriate to focus on the sector where enhanced efficiency could have measurable poverty impacts.

1.4.6 In New Delhi and Calcutta, India, wide ranging discussions were undertaken with different organisations, experts and practitioners to obtain views on the research problem, on the provisional findings of this study and to assess recent developments and initiatives to enhance energy efficiency in industrial and domestic sectors and in environmental management. A list of organisations and persons interviewed is provided at the end of this chapter.

1.5 Plan of Report:

1.5.1 This report is organised in three parts.

1.5.2 Part I contextualises the research problem. The research problem has two components - poverty and energy use. Poverty is first defined and the various approaches to poverty are discussed. The more holistic integrated development approach which recognises the inter-connectivities of environment-poverty relations is used by this study as its analytical framework. Chapter 3 examines the sources and nature of environmental problems affecting the urban poor, with particular emphasis on air pollution. The spatial framework developed by Hardoy and Satterthwaite (1989) to analyse the environmental problems at city, neighbourhood, workplace and household levels is used by this study to draw out the poverty-environment links at different levels. Chapter 4 draws on epidemiological research to show the widespread nature of respiratory diseases attributed to environmental pollution, and to highlight the economic impacts on households and workers of ill health.

1.5.3 Chapter 5 examines the trends, patterns and policies affecting energy use. The objectives here are to relate the study to the wider energy debate and to show that despite the generally upward trend in the use of fossil fuels there are wide variations in fuel mix and pattern of fuel use in Asia. The chapter then looks at India in more detail. It shows that end-use energy efficiency issues are neglected at the policy level as energy policies focus on supply management and environmental policy appears concerned with waste abatement and end-of-pipe measures.

1.5.4 Part II focuses on energy use and its implications for poor urban households. It explores the links between poverty and energy at the household level. Chapter 6 describes the pattern of energy supply and use in developing countries, with particular reference to India. It then examines the household energy-poverty links within the integrated development approach to poverty. Chapter 7 looks at the case of India. It discusses the characteristics of slum dweller and the types of fuels used - the reasons and pattern of variation. It concludes with a discussion of government policies and programmes affecting energy use by the urban poor. Chapter 8 examines the two management options for improving energy efficiency in the domestic sector- improving stoves and assisting people to move up the energy ladder. Each section draws out the policy implications for developing countries as a whole and India in particular. Appendix A gives preliminary guidelines for designing, developing, monitoring and evaluating energy interventions with a poverty focus.

1.5.5 Part III concentrates on industrial sector activities. This section highlights the policy implications for developing energy efficiency programmes; identifies and then examines energy intensive industrial activities which could be targeted for intervention. Chapter 9 shows that, in the context of developing countries, there is a need for a broader perspective within which energy efficiency measures have to be located. Drawing on evidence from Asia and Africa, it argues that focusing only on combustion related pollution will not produce any discernible environmental benefits. However, an energy-led initiative encompassing the issues discussed could improve ambient and work place pollution. Chapter 10 shows that environmental gains in energy intensive sub-sectors of small scale units, employing large number of low income workers and which form clusters in proximity to low income housing, could have considerable impact on poor workers and on the neighbourhood. It shows why benefits could flow to the urban poor from energy-led initiatives in small scale industries and proposes target groups. Chapter 11 identifies high energy using sub-sectors of small scale industries.

1.5.6 Some of the sub-sectors identified in Chapter 11 have already been targeted for enhancing energy efficiency. Chapter 12 assesses these initiatives taken by other lending agencies (e.g. Swiss Agencies for Development and Co-operation), energy research organisations, semi-autonomous government agencies and government agencies to enhance energy efficiency. Other initiatives, one of which is funded by the World Bank, targeting energy and process inefficiencies in small scale industries are also discussed . The chapter concludes with a discussion of the implications for an energy-led initiative.

1.5.7 Chapter 13 sets out the recommendations made by this study

1.6 Definition:

1.6.1 Small scale industries: A small scale unit is defined as one with a maximum of Rs. 6 million (£85K) in plant and machinery. While there is no minimum limit to it, the upper ceiling is relaxed for exporting firms and ancillary units. This limit is slated to increase to Rs. 30 million following recent policy changes. The absence of a lower limit to investment in this sector combined with product protection, subsidised raw material and cheap credit means easy entry and wide variations in size of units. Units employing fewer than 5 persons are referred to as tiny units or micro-enterprises.

1.7 The Study Team

1.7.1 The study team is constituted of the following persons from Natural Resources Institute, University of Greenwich.

Dr. Nandini Dasgupta - Project Manager.
Reader: Employment, Environment and Development.
Mr. Alec Hollingdale - Chemical Engineer
Dr. Abdul Tariq - Energy Engineer
Ms Man Kwan Chan - Social Development
Ms Claire Coote- Socio-economist.

Table 1.1 Organisations, Agencies, Experts and Practitioners Interviewed in New Delhi and Calcutta

Mr. D. Biswas, Chairman - Central Pollution Control Board; Dr. D. B. Boralkar, Assistant Secretary - Central Pollution Control Board.
Dr. S. C. Maudgal - Senior Advisor, Clean Technology, Ministry of Environment and Forests (MoEF).
The Development Commissioner, Small Scale Industries; Directors- Dr. C. S. Prasad and Mr. S. Singh secretaries; Deputy Director - Glass and Ceramics, Mr Sood and Deputy Director -Technology Management, of the same department.
At the Tata Energy Research Institute (the lead organisation in the field) individual and group meetings were held with Dr. R. K. Pachauri, Director; Dr. Ajay Mathur, Dean; Bhujanga Rao- Centre for Information Technology; Sumeet Saksena, Fellow - Energy-Environment Interface; Prosanto Pal, Fellow-Industrial Energy; Somnath Bhattacharjee, Fellow; R. Uma, Environmentalist.
Mr. Chandak, Director, and Mr. Parvez, Deputy Director, National Productivity Council.
Prof. Kirk Smith, University of Berkeley, who was in New Delhi for a conference.
Mr. V. Gupta, Director and Head of National Informatics Centre.
Sunita Narain, Director, Centre for Science and Environment (NGO).
Energy Advisor, Planning Commission. This is the only body with an overall perspective of the energy sector as petroleum, coal, power and non-conventional energy each have separate ministries. Meetings were held with the Mr. Dasgupta, Energy Advisor; Mr. L. P. Sonkar; Advisor- Power; and Mr. A. Mahajan, Advisor- Petroleum.
Malini Kalianiwale, Medical and Psychiatric social worker.
Dr Pankaj Saxena, Ministry of Non-conventional Energy Sources.
Mrs L. Balakrishnan, All India Women's Conference, Rural Energy Department.
Mr. George Varughese Development Alternatives.
Mr. I. Natarajan, National Council for Applied Economic Research.
N. Madhuri, CARE- India.
Dr. T. Kandpal, Indian Institute of Technology, Centre for Energy Studies.
Slum dwellers in Rajiv Gandhi colony and in squatter settlement near Lodhi Road, New Delhi. Bharat Engineering Works, Chamrail, (near Calcutta) where the demonstration plant for improved energy use in foundries has been installed.

2. DEFINING POVERTY

2.1 Definition

2.1.1 In this project poverty is conceptualised as a multi-dimensional problem with an array of interlinked determinants (income generation, environment, housing, health, education, etc.). For practical reasons it accepts the official definition of the 'poor' in India which is based on the income derived poverty line. The rationale for these decisions is discussed below.

2.2 Approaches to Poverty

There are many approaches to defining and measuring poverty. The main approaches are: conventional economic definitions; a social development perspective which expands the definition to include perceptions of vulnerability and entitlements; and thirdly, the integrated development approach which draws on the first two approaches and conceptualises poverty as a multi-dimensional problem. The third, more holistic approach recognises the inter-connectivities of environment-poverty relations, is used by this study as its analytical framework. All three approaches are discussed below.

2.2.1 *Economic definition*

2.2.2 The conventional economic definitions use income, consumption or a range of other social indicators to classify poor groups against a common index of material welfare. Though few would argue that human welfare can be adequately described by income alone, in practice income and/or consumption are the most frequently used proxy for welfare.

2.2.3 The justification is that (in market based economies) income is highly correlated with other causes of poverty and is a predicator of future problems of deprivation. The underlying economic concept is the idea of 'merit goods', which society agrees to ensure that all members achieve. The resulting policy emphasis is on efficient allocation of economic resources for increasing productivity (Wratten: 1995). This is less problematic in the North than in the developing countries where poverty is endemic and society lacks the capacity to provide merit goods for all.

2.2.4 The World Bank and most other government institutions use an absolute definition of poverty (in terms of income and poverty lines), where needs are considered to be fixed at a level which provides for subsistence, basic housing and expenditure on essential services. As many aspects of well-being cannot be captured adequately by economic indicators, supplementary social indicators are used, such as: life expectancy, infant mortality, nutrition, literacy, access to health care and drinking water. To overcome the problems of using single indicators, composite poverty indices have been developed which combine several weighted variables, e.g. Human Development Index. Despite the shortcomings discussed above, standardised definitions are useful in that they provide a uniform scale against which comparisons can be made.

2.2.5 *A social development perspective*

2.2.6 An alternative approach developed by anthropologists and social planners allows for local variations in the meaning of poverty and expands the definition to encompass perceptions of non-material deprivation and social differentiation. Poverty of an individual or a household is a multi-dimensional concept involving in principle, every aspect of direct consumption as well as non-consumption activities and services (Sen: 1987). Fundamental to this approach are the two concepts of vulnerability and entitlements. The former refers to defencelessness, insecurity and exposure to risks, shocks and stress. Entitlement refers to the complex ways in which individuals or households command resources (Sen: 1981). Together, the two concepts allow an understanding of how household resources are used under different conditions of exposure, shock and stress arising from environmental, economic and social situations.

2.2.7 The underlying argument is that causes of poverty lie in the social and political structures, and in the physical and economic environments in which people live (Moser: 1995). It acknowledges the organisational and institutional context within which individuals exist and rejects the notion that they are 'free-floating' in the market (Norton: 1993). The policy concern is attainment of social objectives compatible with the ideal of the just, equitable and prosperous society (Moser: 1995).

2.2.8 This approach allows a greater understanding of causes of poverty and of the complex relationships between vulnerability and entitlements which determine what poverty means to the poor. It permits different types of poverty to be distinguished by drawing on the life experiences of the poor through participatory analysis. However, as the definition of poverty differs with individuals it makes comparative analysis problematic.

2.2.9 *The integrated development approach*

2.2.10 Wratten (1995) argues that neither of the above approaches is sufficient alone. Integrating the understanding of the two approaches (discussed above) provides a better perception of poverty and generates better tools for defining and monitoring poverty. The holistic approach recognises the complex nature of environment-poverty links and provides a useful analytical framework. It is within this context that this study is defined.

2.2.11 This approach accepts that causes of poverty lie in social and political structures and in physical and economic environments in which people live. Poverty is conceptualised as a multi-dimensional problem where structurally rooted determinants (environment, income generation, housing, health, education etc..) are interlinked. Addressing any one of the causes impacts on others. From the perspective of the poor the combined effects of the determinants are encapsulated in the concepts of *vulnerability* and *entitlements* and are central to their well-being. Vulnerability is affected by the ability to earn, the exposure to, and the ability to deal with, shock and stress arising from environmental, economic and social situations. *This implies that ameliorating any one factor of vulnerability, while it does not remove the causes of poverty, could contribute to an improvement of well-being.* The implication for this study is that energy efficiency gains must translate into environmental improvements for the poor, for them to perceive any benefits. It is important to recognise in this case that improved energy efficiency is a means to achieving one of the developmental goals i.e., environmental gains which will benefit the poor.

2.2.12 The focus of this study is therefore, on energy efficiency and the potential for improving the environmental situation of the urban poor. Research (discussed in detail below) has established that there is considerable intra-urban variation in urban environmental and health risks, with greater exposure and risks for the poor. The risks and exposures relate to air and water pollution (in conjunction with inadequate basic facilities) and degradation of resources, and the inability of the poor to alter the situation. The policy intent here is to reduce air pollution at community (workplace and ambient) and household levels through enhanced fuel use efficiency and improved work-place practices.

2.2.13 While the social development perspective allows a better understanding of poverty, its bottom-up approach has limitations for comparative analysis. The *methodological implications of integrated development* approach for measurement are that quantitative and qualitative assessments are complementary (Wratten: *ibid*.). The quantitative poverty indicators are required to estimate the distribution and depth of deprivation within cities and countries. On the other hand, qualitative analysis through participatory appraisals provide insight into social structures and processes which affect different groups. This study will draw on qualitative and quantitative tools as considered appropriate.

2.3 Who are the poor?

2.3.1 Most official definitions of poverty are based on an absolute definition of poverty. Absolute poverty is defined as the inability to secure basic minimum needs for subsistence, housing and expenditure on essential services such as water, sanitation, health, education and transport. This inability is measured in terms of income and described as the 'poverty line'. Thus, according to most official definitions, those whose incomes are below the 'poverty line', are defined as the poor. India also uses the poverty line to defines its 'poor'.

2.3.2 Studies have shown that poverty measurement based on income leads to gross under-estimation of urban poverty. In many countries a considerable proportion of the urban population who are 'above the poverty line' lack the income or assets to ensure their needs are met. Swaminathan (1995) noted that very large proportion of the urban population in Mumbai whose incomes are above the 'poverty line' are no better off than the officially defined poor.

2.3.3 The Central Statistical Organisation, India, has recognised the difficulties of assessing the income of low-income households since the early 1980's. It uses per capita monthly expenditure to categorise the population into fractiles based on consumption levels. It is officially accepted that those fractile groups below the 'poverty line' are the poor. Using expenditure rather than income overcomes some methodological difficulties, but does not resolve the issue of under-estimation as it uses the poverty line as a cut-off point. The government of India's sets the urban poverty line at Rs. 1,975 per month (Economic Survey 1997).

2.3.4 Composite indices like the Human Development Index which aggregates income, literacy and life expectancy into a single measure on a scale of zero to one is an improvement. However, it does not capture all aspects of poverty, nor the poor' perspective of it. On the other hand, using participatory analysis to define poverty and the poor is time consuming and by nature a highly localised exercise.

2.3.5 Keeping in mind the limitation of using single indicator index, this study relies on the official definition of poor in India.

3. POVERTY, ENVIRONMENT AND AIR POLLUTION

3.1 Introduction

3.1.1 Before examine the links between environmental improvements and benefit flows to the poor in terms of health and income gains, it is necessary to describe the pattern and nature of environmental problems affecting the urban poor. This chapter describes the source and nature of environmental problems affecting the urban poor with particular emphasis on air pollution.

3.2 Framework of Analysis

3.2.1 Hardoy & Satterthwaite's (1992) work on environmental problems in cities of developing economies provide a useful analytical framework. Their discussion of urban environmental problems is spatially broken down into four levels. These are

(i) The city environment;
(ii) The neighbourhood environment;
(iii) The workplace environment; and
(iv) The environment at home.

This framework has been widely used for analysis by researchers focusing at different levels. Some examples are, Douglass (1992) - city level analysis; Jacobi (1994) - households and environment; J. Leitmann *et al* (1992) urban development and environmental management. This study adopts this framework of spatial organisation to discuss the impacts of air pollution on the urban poor.

3.3 Spatial Analysis of Urban Environmental Problems

(i) The City Environment

3.3.1 The relationship between urbanisation, environmental degradation and urban poverty has attracted considerable attention from researchers and policy makers. The literature underscores (i) the complexity of the problem in terms of environmental risks; and (ii) intra-urban differentials in the impacts of environment related risks.

3.3.2 *Environmental Risks*: Urban environmental problems in developing countries are much wider in scope and larger in magnitude than those conventionally considered in the West (Shin: 1992). The Risk Transition Model adapted by Shin from Smith (1990) captures some of this complexity and helps to understand it. It argued that in the West, development was accompanied by a 'risk transition' i.e., first a decline in traditional health risks associated with low levels of well-being followed by a rise in modern risks associated with pollution. With reference to Asian cities, Shin notes that modern risks of pollution were introduced before the poverty-related risks had been tackled. This means that cities in developing countries are experiencing the worst of both situations.

These risks are as follows:

Poverty-related health risks include:
- Malnutrition
- Bowel diseases
- Environmental disease vectors
- Food spoilage
- Cooking fire pollution
- Polluted surface water

Modern Health risks include:
- Automobile and industrial pollution
- Pesticide poisoning
- Ground water pollution
- Radioactivity
- Indoor air pollution
- Toxic chemical releases

It is pertinent to add that though policy and research focus on major cities, secondary cities suffer similar problems.

3.3.3 *Intra-urban differences*: Harvey (1975) noted that urban settlements develop in order to group enterprises in a cost-effective spatial configuration. Opportunities for work attract people to urban centres. Cheap housing and industrial activities tend to be located on lower cost land in urban areas. Hardoy, Craincross and Satterthwaite (1992) have shown that this spatial juxtaposition of industrial and low income housing, in conjunction with absence of planning and environmental control, create special environmental and health risks for the poor. In other words, in addition to facing poverty related environmental risks, the externalities of urban production are also borne disproportionately by the poor (Wratten: 1995).

3.3.4 According to Hardoy *et al* (i*bid.*) 600 million urban residents of the developing countries live in life and/or health threatening homes and neighbourhoods. Some of the risks are diseases associated with contaminated water and food, and with overcrowding, poor drainage, poor hygiene. More importantly for this study, respiratory infections related to poor ventilation, indoor and outdoor smoke from cooking fires; to ambient pollution from industry and traffic; to work place air pollution from inefficient use of resources and poor work practices.

3.3.5 (ii) Neighbourhood Environment

3.3.6 Risk in neighbourhood environment has three principal sources: the site; no collection of household garbage; and inadequate site infrastructure. Low income housing and squatter settlements tend to locate on land for which there is a relatively low demand. It therefore tends to be prone to natural disasters like flooding, subsidence, landslides, etc. In other instances it is located near land-fill sites or garbage dumps or in and around industrial areas with high levels of air pollution. Localised problems of high levels of air pollution occur more widely, in and around particular type of industry with high levels of polluting emissions (Dasgupta: 1997). Studies have shown the high levels of lead oxide, suspended particulate matter and other emissions of inefficient combustion in the neighbourhood of lead smelting industries (*ibid.*), iron foundries (GHK/ODA: 1994) and other metal processing units.

3.3.7 Burning of unsorted household garbage (as there is no collection) often contributes to ambient pollution (Surjadi: 1993). Low income workers like street traders are constantly exposed to pollution from vehicular traffic. Also exposed are the squatter settlements under bridges and other available infrastructure. However, this study does not examine the effects of vehicular pollution.

3.3.8 (iii) The Workplace Environment

3.3.9 Environmental hazards in workplace are a major problem in cities of developing countries. The nature of the problem varies with the type and scale of industry. Public sector units and large industries with unionised labour are comparatively better off. It is the medium and small industries with a weak, disorganised labour force that some of worst working conditions are found. Any objections to poor working conditions would probably be at the cost of the workers' jobs. Moreover, lack of implementation of environmental laws and of health and safety standards, leaves the workers highly exposed to risks of injury, disablement or even death. Once a worker is injured or sick it could mean loss of livelihood as no provisions are made by employers for compensation or sick pay. A longer term threat to their livelihood opportunities comes from the closure of these units as they are unable to meet the environmental standards.

3.3.10 Pryer (1993) reports from a cross-sectional household survey in Khulna, Bangladesh, that 24% of households lost labour days due to illness or accident at work in the month prior to the survey. Pryer also notes that medical expenses were higher than the income lost due to incapacitation from wage work.

3.3.11 Small and medium industries, officially encouraged because of their employment generation potential, are involved in manufacturing and processing wide range of materials and chemicals. Experience (Scott: Zimbabwe and Bangladesh: Bartone: Nairobi; Dasgupta: India). shows that in these small and medium units, even though some of them are high energy users, combustion is not the main source of pollution. High levels of pollution is more attributable to poor work practices and attitude to pollution. This is discussed in detail in the chapter titled ‘Development Perspective and Energy Efficiency’.

Table 3.1 Examples of Air Borne Toxic Chemicals, Their Use and Their Potential Health Impacts.

Asbestos	Roofing insulation, air conditioning conduits; plastics, fibre; paper	Carcinogenic to workers and even to family members
Beryllium	Ceramic parts; household appliances	Fatal lung disease: lung and heart toxicity
Lead	Pipes, batteries, paints; printing plastic; smelting;	Intoxicant; neurotoxin affects blood system.
Sulphur dioxide	emissions for coal/oil combustion.	Irritation to eyes and respiratory system.

Source: Hardoy and Satterthwaite (1992).

3.3.12 (iv) Environment At Home

3.3.13 The environment at home is conditioned by the presence of pathogens in air and water, lack of drinking water and the presence of air borne pollutants and its rapid transmission because of over crowding.

3.3.14 Air pollution at home: Where open fires or relatively inefficient stoves are used indoors for cooking and/or heating, smoke or fumes from coal wood or other biomass fuels can cause or contribute to serious respiratory problems (Hardoy: 1992). According to WHO (1992) chronic effects include inflammation of the respiratory tract which in turn reduces resistance to acute respiratory infections, while these infections in turn enhance susceptibility to the inflammatory effects of smoke and fumes. Turner *et al* (1990) showed the high risk to women who spend two to four hours at the stove using biomass fuels, as they are exposed to carcinogens in the emissions. Children may also be at risk as they remain with their mother. This exposure combined with malnutrition can retard growth. Kirk Smith noted that in his recent study (yet to be published) on indoor air pollution in India, he had estimated that there were 500,000 in-door pollution related premature deaths.

3.3.15 In Indian cities where kerosene, coal, wood and other biomass are used as domestic fuels, air pollution from domestic stoves is significant (CSE: 1997). Douglass (1992) notes that in Seoul oil and anthracite briquettes used for domestic cooking and heating contribute to high levels of air pollution. In China raw coal is still used by millions in small inefficient stove even though China has had greater success than India in disseminating improved stoves (Smith -interview).

4. ENVIRONMENT AND HEALTH IMPACTS

4.1 Air Pollution and Respiratory Diseases

4.1.1 A considerable part of epidemiological research is centred on the association between respiratory disease and the environment. This section draws briefly on this research to show the widespread nature of the problem and to highlight the economic impacts on households of ill health.

4.1.2 In the context of intra-urban disparity, Songsore and McGranahan (1993) note that understanding the relationships between health, environment and urban development is crucial to developing environmental health programmes and for improved environmental management. In modelling the relationships between environment, health and wealth they argue that morbidity differentials (in Accra) are functions of synergistic interaction between environmental risk factors and socio-economic circumstances. The defence mechanism which ensure protection from environmental health risks is conditioned by household/individual’s access to clean water, sanitation, garbage removal; access to medical services; adequate nutrition and shelter; and hygiene practice. The poor thus experience greater exposure and have lower ability to protect themselves.

4.1.3 The authors note that it is often difficult to establish the relationship between morbidity rates and explanatory factors. For example, in Accra, the prevalence of childhood acute respiratory infection at 12% was roughly comparable with diarrhoea prevalence, but the association between incidence of respiratory problems and explanatory factors were less strong than for diarrhoea. In the case of respiratory disease it is more difficult to remove ‘statistical noise’. Despite these difficulties, research continues to suggest associations between air pollution and respiratory problems.

4.1.4 A review (Bradley *et al*: 1992) of environmental health impacts in Third World cities proposed five environmental factors associated with respiratory disease:

* indoor density
* indoor pollution, especially the cooking stove
* air pollution in the community
* air pollution due to industry
* air pollution due to transportation.

4.1.5 They note that acute respiratory infections (e.g., pneumonia) are a major cause of infant and child death in urban areas although their extent and risk factors associated with them remain poorly understood.

4.1.6 In a study of respiratory disease and environmental factors in households in Jakarta, Surjadi (1995) found that 42.2% of the disease were related to respiratory infections. 33.5% of mothers with respiratory diseases were from low-income households against 18% from high income households. The study suggests that there is an association between the occurrence of maternal respiratory diseases and firewood utilisation. Smith’s study (forthcoming) notes that continuous exposure to indoor pollution increase the risk to tuberculosis by two and a half times.

4.1.7. An exercise was undertaken by TERI to demonstrate the effects of indoor pollution on the respiratory system of women. They used two filters to show the difference between clean and polluted environment. On seeing the filters one women asked “Is this the way my lungs look?” It appears that while they are aware that smoke can be harmful, they do not fully appreciate the gravity of the problem of spending long hours cooking over inefficient stoves in poorly ventilated rooms

4.2 Health and Income

4.2.1 In examining the impact of ill-health on household income and nutrition Pryer (1993) notes that women and children are severally affected when the male breadwinner suffer incapacitating ill-health. The forgone income and additional medical expenses often lead to greater indebtedness.

4.2.2 In summary, it can be said that respiratory disease attributed to air pollution is widely prevalent among the poor. Though research continues to suggest strong associations with explanatory variables it has been very difficult to establish direct links. However, it can be said the respiratory diseases reduce the ability to withstand other infections and leads to generally poor health. Loss of working days due to ill health has direct economic implications in terms of income lost and medical expenses incurred.

Table 4.1 Sources of Air Pollution and Possible Health Impacts.

Pollutant	Reason	Health impacts	Source
Carbon Monoxide	Incomplete combustion of oil, coal and natural gas and other organic matter.	Reduces the capacity of the blood to carry oxygen, and in prolonged high concentration can cause death. Contributes to headaches and fatigue and aggravates heart and respiratory diseases	Factories and homes with inefficient heating and cooking appliances. Vehicle exhausts
Hydrocarbons	Incomplete combustion of fuel by motor vehicles and evaporation of industrial solvents	Injure respiratory system and some cause cancer.	Motor vehicles and industry
Oxides of nitrogen	High temperature fuel combustion	Aggravate respiratory and heart diseased; irritate lungs when dissolved to become acid rain.	Motor vehicles, power plants and industries.
Oxides of sulphur	Burning of coal and oil containing sulphur	Aggravate respiratory and heart diseased; irritate lungs when dissolved to become acid rain. Irritate eyes and respiratory tract.	Homes, factories and power plants.
Suspended particulates	Smoke, dust, soot and liquid and other solid particles suspended in the air.	Depending on their size and composition these can cause cancer, aggravate respiratory and heart diseases. Cause irritation to throat and chest.	Homes, factories, power plants and motor vehicles.

Source: Hardoy and Satterthwaite (1989) The Squatter Citizen.

5. ENERGY USE: TRENDS, PATTERNS AND POLICIES

5.1 Introduction

5.1.1 The objectives of this chapter are (i) to contextualise this study in the wider energy debate; (ii) to show that despite the generally upward trend in the use of fossil fuels there are wide variations in fuel mix and pattern of use of fuel in Asia; and (iii) to describe the trends and patterns of energy use in India, and the energy policies affecting their use. Section 5.5 also shows that end-use energy efficiency issues are neglected in India as the energy policy focuses on supply management, and environmental policy is concerned with waste abatement and end-of-pipe measures .

5.2 Sustainable Development and Energy Efficiency

5.2.1 In 1992, Agenda 21 noted that one of the ways of promoting sustainable development is to reduce the adverse effects of the energy sector. It identified two directions in which the energy system could evolve: (i) towards more efficient production, transmission and distribution and end-use of energy; and (ii) towards greater reliance on environmentally sound energy systems. This study by focusing on enhancing efficiency in end-use of energy in industry contributes to the first path of change.

5.2.2 Energy is also an essential ingredient of socio-economic development and economic growth. The objective of energy system is to provide *energy services.* Energy services are the desired and useful products, processes or services that result from the use of energy, for example illumination, appropriate temperatures for cooking etc. The poor pay a much higher price for their energy services than any other group in society (reasons discussed in detail in Part II). The price can be measured in terms of time and labour, economics, health and social inequity, particularly for women (UNDP: 1996). Enhancing cooking fuel efficiency in poor households and/or assisting households to 'climb the energy ladder' could have positive consequences for women, their households and the environment. (Discussed in more detail in Part II).

5.2.3 This argument is reinforced by a recent quantitative analysis undertaken by Smith *et al* (1998) in China. It examined the health impacts of reducing greenhouse gases through increase in end-use efficiency in industry and the household sector. It notes that economic benefits of improved health can be substantial.

5.3 Pattern and Trends of Energy Use in Developing Countries

5.3.1 Energy use varies considerably in the world. According to World Energy Council there was a 20-fold difference between North America and South Asia in 1993. In developing countries fossil fuels contribute 78 per cent and renewable sources of energy 18 per cent of total consumption. 60 per cent of the latter is traditional biomass. The biomass contribution in industrialised countries is below 2 per cent.

5.3.2 Overall consumption of energy is increasing in some Asian countries as shown in Table 5.1 . However, there is considerable variation in the ratio of fossil fuel to traditional biomass among Asian countries. This is illustrated in Table 5.2. This is indicative of the level of industrial development of a country and has implications for energy policy, as fuel efficiency varies with the fuel. (Table 5.3).

Table 5.1 Energy Consumption per Capita/Annum, kg oil Equivalent in Selected Asian Countries

Country	1973	1983	1993 Source World Bank	1993 Source IEA	1996	Trend
China		299	435	632	635	UP
Indonesia	87	177	330	366	440	UP
India	114	157	243	244	293	UP
Nepal	10	11	22	24	24	-
Singapore	1864	2780	5563	9184	9770	UP

Note: The International Energy Agency (IEA) estimates for 1993 generally exceed World Bank estimates for the same year. However, there is considerable difference in estimates for Singapore.

Table 5.2 Showing the Trend in use of Traditional Fuel and Fuel Mix in Selected Asian Countries.

Country	Traditional Fuels		
	Petajoules 1993	% change 1973-93	% of total (all fuels) Consumption in 1993
Bangladesh	277	27	47
China	2018	54	6
India	2824	58	23
Indonesia	1,465	54	36
Myanmar	193	48	73
Nepal	206	88	92
Pakistan	296	101	21
Singapore	0	0	0
Sri Lanka	89	45	53

Source: World Resources 1996-97.

Table 5.3 Comparison of Air Pollutant Emissions in kilograms Per Unit of Energy Delivered.

Use and Scale Fuel Efficiency		Amount equivalent to 1 million MJ delivered	Particulates	Sulphur Oxides	Nitrogen Oxides	Hydro-Carbons	Carbon Monoxide
Industrial (>20 KW)							
Wood (70%)	tonnes	89	500	53	400	400	450
Bituminous (80%)	tonnes	43	2,800	820	320	22	46
Residual oil (80%)	litres	33,000	90	1,300	240	4	20
Distillate oil (90%)	litres	31,000	8	1,100	83	4	19
Natural gas (90%)	m^3	28,000	7	neg.	99	2	8

Source: UNDP (1996)

Note: The document did not provide the basis for the data, but due to the magnitude of the efficiency values quoted it is likely that the data are based on net calorific value.

5.3.3 In India and China there has been a growing reliance on fossil fuel for industrial use and for power generation. In Sri Lanka, traditional biomass (see Table 5.2) is still the most important industrial fuel. The level of industrial development is relatively low (though it scores well on Human Development Index) and agro-based industries dominate its industrial structure. It was considered pertinent to look at a case study which highlights the opportunities for, and constraints to, enhancing energy efficiency where fuelwood is the dominant industrial fuel.

5.4 Fuelwood and Energy Efficiency Case Study - Sri Lanka

5.4.1 Biomass is the principal domestic and industrial fuel in Sri Lanka and both household and industrial utilisation of fuelwood in Sri Lanka is very high for South East Asia. Estimated industrial consumption of fuelwood is $2x10^6$ tonne annually out of a total of 9.5×10^6 tonne (Leach, 1987).

5.4.2 The analysis is built upon the results of a technical study of the atmospheric emissions and thermal efficiencies of typical process plant used in major industries. It reported on 9 fuelwood-fired air heaters used in desiccated coconut and tea industries; and 5 steam boilers fired with fuelwood, coconut shells and sugarcane bagasse (Tariq and Purvis, 1996). These measurements established the following average values for plant performance: emissions of nitrogen oxides (NO and NO_2) of 47g NO_2/GJ of biomass fuel fired; and thermal efficiency of plant (based on Gross Calorific Value) of 50%.

5.4.3 *Environmental Legislation In Sri Lanka*

5.4.3.1 The major item of legislation relating to industrial pollution is the National Environmental Act, No 47 of 1980 (Government of Sri Lanka, 1980 and 1988). The Act, strengthened and amended in 1988, established the Central Environmental Authority (CEA). The primary functions of the CEA are the formation, regulation, monitoring and co-ordination of the environmental policy of Sri Lanka. The 1988 amendment prohibits the discharge, disposal or emission of waste without the prior approval of the CEA. The CEA gives this approval through the issuing of licences.

5.4.3.2 The legislation, in principal, is sufficient to control industrial pollution. However, there are several practical constraints that limit effectiveness. These largely relate to the institutional and technical capability to fully licence and regulate industry. Other constraints also need to be addressed. In many cases established standards are lacking or inadequate, and where standards exist data collection is unreliable - often the instrumentation available is limited or not available at all. There appear to be few incentives for industry to adhere to the standards since there is no effective enforcement mechanism in practice. Authorities in Sri Lanka estimate that 5000 companies require licences, but only a quarter of these have been granted. The majority of companies operate without a licence.

5.4.3.3 Although the National Environmental Act is the major item of legislation concerning industrial pollution, Government environmental priorities are outlined in the National Environmental Action Plan 1992 - 1996 (Government of Sri Lanka, 1991). This is an ambitious programme to address a whole range of environmental concerns. The plan covers aspects of forestry, bio-diversity, coastal resources, land and water resources and pollution - urban and industrial.

5.4.3.4 Most discussions of industrial pollution concern water quality, waste abatement and industrial development in environmentally sensitive areas. In general, these are the areas of high visual impact laying claim to public concern. The Action Plan gives far less attention to the more ubiquitous environmental impacts of air pollution from industrial combustion processes but there are proposed emissions to air standards for new or modified steam generators.

5.4.4 *Energy Use In Sri Lanka*

5.4.4.1 *Energy Consumption*: Figure 5.1 shows energy consumption, by sector, of the economy on an oil equivalent basis. Total energy consumption was approximately 6.1 million tonne oil equivalent (toe) in 1992. The consumption of fuel oil (light oil and residual oil) for industrial purposes was $242.5x10^3$ tonne

The household sector is the most important consumer of energy, accounting for 61.6% of total consumption, followed by the industrial sector (18.4%) and transportation (14.6%). Total energy use increased by 27% over the previous decade due to: population growth, economic growth, increases in living standards and increased industrial production. Energy use has grown in similar proportions across all sectors of the economy.

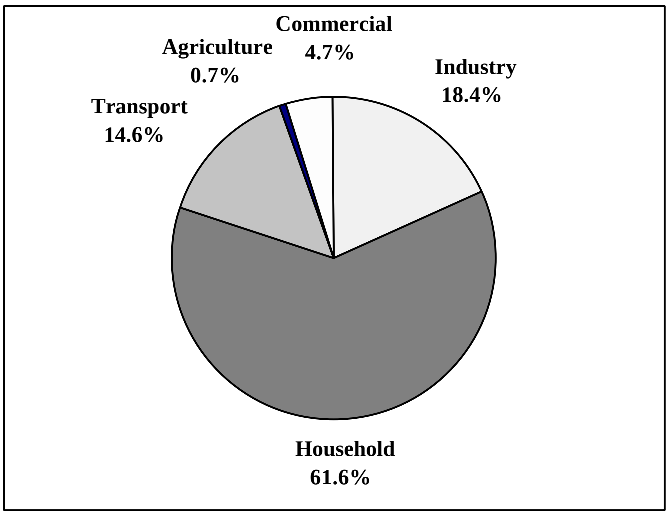


Figure: 5.1 Energy Consumption (1992) by Various Sectors of Economy as Percentages of Total Annual Consumption of $6.1x10^6$ tonne of oil equivalent (toe)

5.4.4.2 *Energy Supply*: Figure 5.2 shows the total energy supply for Sri Lanka for 1992 on an oil equivalent basis. In 1992 the total energy supply was 6.1 million tonne oil equivalent. Biomass (including bagasse and charcoal) is the most important source of energy and accounts for 66% of the energy supply.

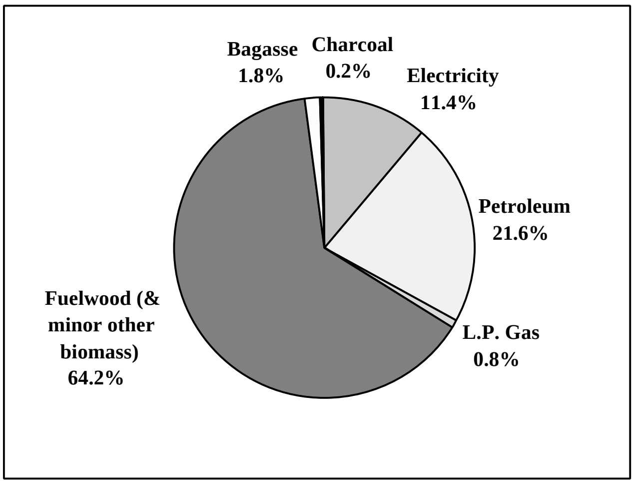


Figure 5.2 Contributions of Different Sources of Energy (1992) to a Total Supply of $6.1x10^6$ toe (small contribution of 0.01% from coal not shown).

The increase in supply from 1982 has largely been met by increases in electricity production of 73% and in biomass use of 22%.

5.4.5 Biomass Consumption and Supply

5.4.5.1 Approximately 11 million tonne of biomass were consumed in 1992. Household use accounts for 78.6% of all the biomass consumed for energy. Bakery, brick and tile, tea, hotels and eating houses, and sugar are the most important industrial and commercial users of biomass fuels.

5.4.5.2 Firewood is the major source of biomass and accounts for 68% of the total tonnage. This is followed by coconut residue (17%) and rubber plant residues (6%). Biomass from rice husks and bagasse are used solely by the rice milling and sugar industries, respectively, and any unused biomass is wasted.

5.4.5.3 As fuelwood accounts for such a high proportion of total energy supply, it is important to determine its sustainability. Table 5.4 shows the major sources of fuelwood and the potential (or actual) quantities available per annum over the 1985 - 90 period (Howes, 1989). Fuelwood used by households and industry was obtained from a number of differing sources.

Table 5.4 Annual Potential Fuelwood Production by Source 1985-1990 (Howes, 1989).

Category	Fuel Source	'000 tonne	%
Commercial	Rubber	2012.1	12.2
	Coconut	204.4	1.2
	Forest	7434.0	45.0
	Sub-total	**9650.5**	**58.6**
Other Fuelwood	Home Garden	898.2	5.4
	Sparsely used Cropland	820.1	5.0
	Cinnamon	154.0	0.9
	Shade Trees	151.0	0.9
	Other	105.0	0.6
	Sub-total	**2128.3**	**12.8**
Other Fuel	Home Garden	1270.4	7.7
	Coconut	2106.6	12.7
	Palmyrah	330.6	2.0
	Tea	920.3	5.6
	Other	131.1	0.8
	Sub-total	**4759.0**	**28.8**
	TOTAL	**16537.8**	**100.0**

5.4.5.4 Commercial wood is the most important source of fuelwood, accounting for 58.4%. Of this, wood from forests is the most significant component accounting for 45% of the total annual production. 7.434 million tonne of fuelwood from natural forests was estimated to have been obtained from clear felling of 42000 hectares of dry-zone forests around the Annuradhapura region (Howes, 1989). Most of the fuelwood used by the industrial sector is from the "commercial" category.

5.4.5.5 Rubber wood is the most important source of fuelwood used in the industrial sector (49%) followed by natural forest wood (36%). Rubber wood is a particularly important source of fuelwood for the rubber (88%), bakery (63%), tea (69%) and hotels/eating houses (64%) sectors. The natural forest is an important source of fuelwood for the pottery (59%), coconut (88%) and tobacco (74%) industries.

5.4.5.6 *Costs of Production*: In percentage terms, fuelwood costs are the most important for the brick and tile industries (28% and 27% respectively). For the desiccated coconut and tea industries, fuelwood costs account for 4% of total costs, the major costs being for raw materials - coconut and tea respectively. Fuelwood costs, though, are an important component of the processing costs. A large variation was reported by factory managers in both the use and cost of fuelwood. In the rice and sugar industries, the fuel used is generated as a residue from processing the raw material, i.e. rice husk and sugar cane fibre (Bagasse) respectively. The costs of biomass use, therefore, are negligible.

5.4.6 *Benefits Of Increased Energy Efficiency Of Industrial Biomass Fuels*

Three sets of benefits accrue:

(a) Operational Costs

The results of the plant performance evaluation study carried out in Sri Lanka provided an average thermal efficiency of 50%. The reasons for this low efficiency were identified as (Tariq and Purvis, 1996):

- lack of training and understanding of good combustion practice by the supervisors and operators of the systems;
- poor maintenance of combustion plant;

- use of plant beyond its design capacity;
- inadequate drying of fuel;
- operation of plant at high excess air levels.

5.4.6.1 Most of these items are remedied by the adoption of operator training and good housekeeping measures. There is considerable potential for increasing the thermal efficiency of fuelwood combustion systems from the current average of 50% to 70% or more. A gain in efficiency of 20% (from base of 50%) leads to a national fuelwood saving of 40% in the industrial sector.

5.4.6.2 Potential for reductions in annual fuelwood consumption for important industries were calculated assuming an increase in plant thermal efficiency from 50% to 70% and by including the average price of fuelwood, the annual monetary value of savings may be estimated. This is shown in Table 5.5.

Table 5.5. Potential for Annual Fuelwood Savings Over All Industries.

Fuelwood savings at 40% reduction in use, '000 tonne	Fuelwood cost Rs/tonne	Value of potential fuelwood savings, million Rs
676	755	509.9
Average cost of fuelwood Rs 490/m³ (Table 8) 1 m³ fuelwood = 0.65 tonne		

The three important requirements for increasing the efficiency of fuelwood use are:

- reducing the moisture content of fuelwood by adequate storage;
- training of factory operators;
- instrumentation for assessing excess air levels.

5.4.6.3 In the case of the moisture content of fuelwood, storage of fuelwood of 55% moisture content for 6-7 weeks in well-ventilated simple structures under ambient conditions would result in fuel savings of approximately 27%. The capital invested in the buffer store (6-7 weeks supply) would be repaid in approximately 22 weeks through the savings. In most factories, the potential for use of heat in the flue gases for drying of fuelwood exists (Joseph *et al*, 1995). A study (World Bank, 1986) calculates a 2.7 year repayment period for heated stores in the tea industry. A major factor in low efficiencies of the fuelwood-fired appliances was lack of training of the factory personnel. A financial appraisal (Joseph *et al*, 1995) of the establishment and operation of a nucleus fuel advisory service over a five year period shows an internal rate of return (IRR) of 156%. The analysis is based on the assumption that 10% of fuelwood, used in the desiccated coconut and tea industries, is saved. The benefits of such an advisory service would not be restricted to the two industries used in the financial analysis.

5.4.6.4 In addition to the reductions in the use of fuelwood through better efficiencies, further reductions are possible by the substitution of fuelwood with residues such as sawdust and rice husks. The beneficial use of these residues for the provision of process heat, therefore, has many advantages.

(b) Forest Resources

5.4.6.5 It is estimated that clear-felling of 42000 hectares of natural forest in Sri Lanka yielded 7.434×10^6 tonne/annum of fuelwood (Howes, 1989). These figures led to a fuelwood yield of 177 tonne per hectare from clear-felling of the natural forest (mainly dry zone forests). Taking this figure, the area of forest which could be saved, by gains in the efficiency in the industrial use of fuelwood, is 3815 hectare per annum, and this represents 9.1% of the annual deforestation of 42000 hectares attributed to the requirements for fuelwood.

5.4.6.6 The above small, but significant, potential savings must be seen against the background of continued decline in the natural forests in Sri Lanka (figure 3). The present pattern of supply for fuelwood cannot be sustained for more than 20 - 30 years and the effects are likely to be felt much earlier than this (Howes, 1989).

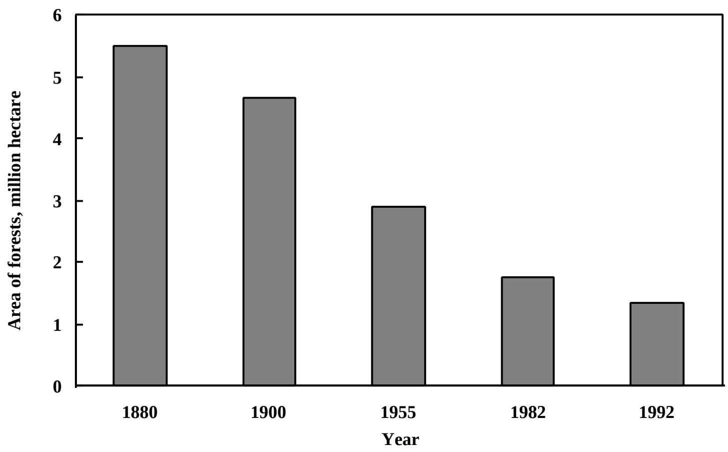


Fig 5.3 Decline in the Natural Forest Cover in Sri Lanka.

(c) Atmospheric Emissions

5.4.6.7 CO_2 emissions for the year 1992, compared with those that would result if fuel efficiency measures are implemented are shown in Figure 5.4. These indicate that the potential for emissions reductions is about 10^6 tonne per annum and would be a significant contribution at a national level in the terms of the Climate Change Agreement. The figure does not include any reductions in CO_2 emissions which would result from the improved efficiency of industrial combustion appliances using fuel oil and other biomass.

5.4.6.8 Annual NO_x emissions, based on 1992 consumption data have also been calculated against what the emissions would be if thermal efficiencies of fuelwood fired plant were increased from 50% to 70%. The reduction in NO_x emissions for fuelwood amount to 530 tonne per annum. The figure does not take into account possible reductions from the more efficient use of other biomass fuels and fuel oil.

5.4.6.9 This data should be seen in the context of the total national biomass energy usage. Biomass used in households was 3.8 times that used in industry in 1992. Nevertheless, the improvements in the industrial use of biomass materials for combustion will make small but significant contributions to:

- reduction in CO_2 emissions;
- reduction in NO_x emissions;
- reduction in the rate of deforestation;

- reduction in deforestation will contribute towards the security of indigenous fuel supplies; and
- photosynthetic removal of CO_2 from the atmosphere.

Major benefits will accrue from efficiency improvements in the use of household fuelwood. However, this is less easily accomplished than in the case of industrial practice.

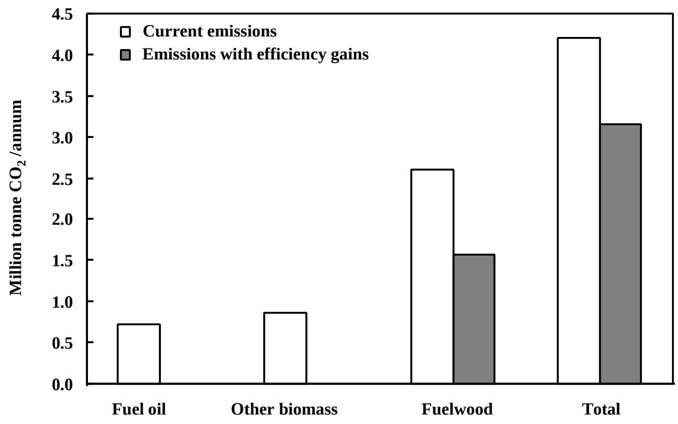


Figure 5.4 Emissions of Carbon Dioxide from Industrial Combustion Sources in Sri Lanka.

5.5 India: Energy in the Policy Context.

5.5.1 There are three points to be made that are pertinent to this study. One, the increasing reliance on fossil fuel as industrialisation is seen as the vehicle for development; two, energy policy in India essentially focuses on supply management; and three, the environmental policy is concerned with waste abatement rather than increasing resource use efficiency. Consequently, issues relating to enhancing energy efficiency of industrial fuel use receive little attention. This section discusses each of these in turn.

5.5.2 Energy Consumption in India

5.5.2.1 A major thrust in India's development planning has been the emphasis on industrial development. Technology and capital intensive, large scale modern industrial sector was to lead the transition from agriculture dominated economy to an industrialised economy. Energy was seen as crucial to this shift and huge public sector investment went into construction of super thermal power stations and mega-hydroelectric power projects. In acknowledgement of the limited employment generation capacity of the capital-intensive sector, industrial policy encouraged the small and medium sized industries. Subsidies, cheap credit and land is often made available. The overall impact is increase in industrial production in units ranging from large scale, modern units to small-scale factories operating at the margins of technological change. Pertinent to this study is the rapid increase in industrial fuel consumption in industries of all sizes.

5.5.2.2 Since 1951 there has been a growing dependence on energy production from fossil fuels. This is illustrated in Fig 5.5. Within fossil fuels there has been a movement away from crude petroleum to coal and to some degree, natural gas (Reidhead *et al*: 1996). India's oil production has declined following the ageing of its oil fields. The production of coal has maintained an annual rate of approximately 4.5%. The quality of Indian coal is low (Grade E) and has a very high ash content, i.e., large emissions of fly ash. Biomass remains an important source of energy as poverty persists and economic disparity increases. It is the main household fuel in rural India.

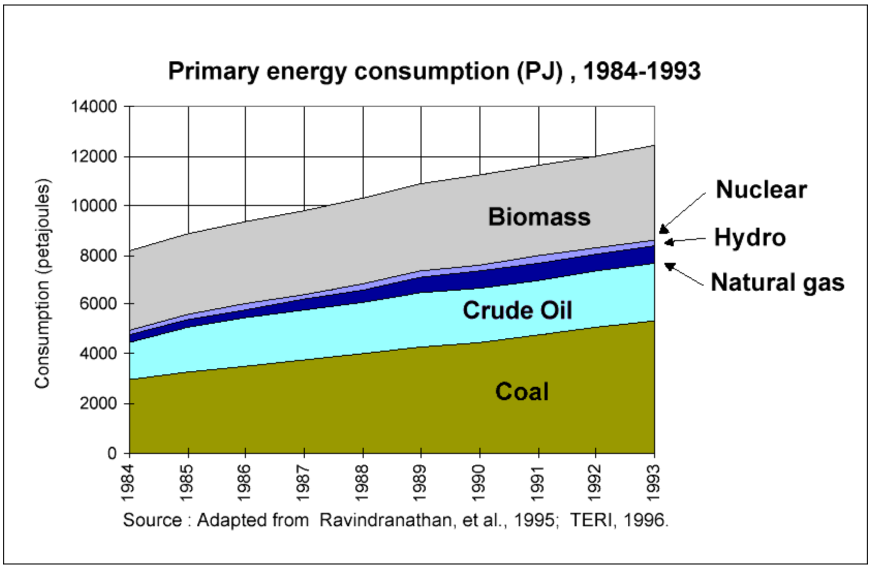


Fig 5.5 Showing Trends in Primary Energy Consumption in India

5.5.2.3 In 1996 India's per capita per annum energy consumption was 293 kg oil equivalent growing at approximately 4.5% since 1987. In the period between 1985 and 1991 per capita electricity consumption expanded by 50% (TERI: 1996). Although the share of biomass in the total energy mix has fallen from 40% in 1984 to 30% in 1993, the net consumption of biomass has grown by 15% since 1984.

5.5.2.4 The impact on the environment of increase in fossil fuel use in India is well documented. However, it is pertinent to note some of its salient features. The dominant source of urban pollution in urban India is vehicular pollution. A study by the Central Pollution Control Board shows that in Delhi industries (large and small) contribute 29% to the total air pollutant emissions (see fig 5.5).

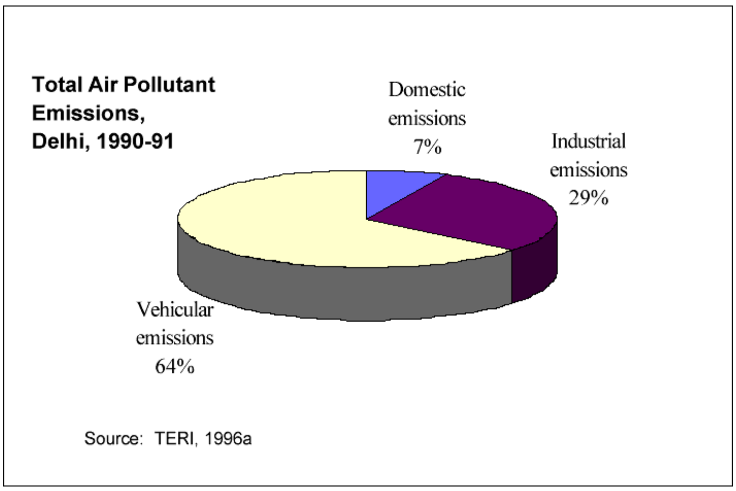


Fig 5.6 Showing Total Air Pollutant Emissions in Delhi

5.5.2.5 A National Ambient Air Quality Monitoring Programme (1995) was jointly undertaken by the Central Pollution Control Board and the National Environmental Engineering Research Institute. The results for the DFID partner states are given in Table 5.6. It is interesting to note that air quality in terms of SPM is poorer in residential than in industrial areas.

Table 5.6 Showing Ambient Air Quality in Selected States of India.

	SO_2				NO_2				SPM			
	1994		1995		1994		1995		1994		1995	
	I	R	I	R	I	R	I	R	I	R	I	R
Andhra Pradesh												
Hyderabad	L	L	L	L	L	M	M	M			M	H
Orissa												
Angul	L				L				L	H		
Rourkela	M	L	M	L	M	L	L	L	M	H	M	H
West Bengal												
Calcutta	M	M	M	M	L	M	L	M	H	C	H	C
Howrah	L	C	L	C	C	C	C	C	L	C	M	C

Source: Central Pollution Control Board (1996).

Note: L= Low; M = Medium; H = High; C= critical, are the indicators on the basis of range of values designed for industrial = I and Residential = R.

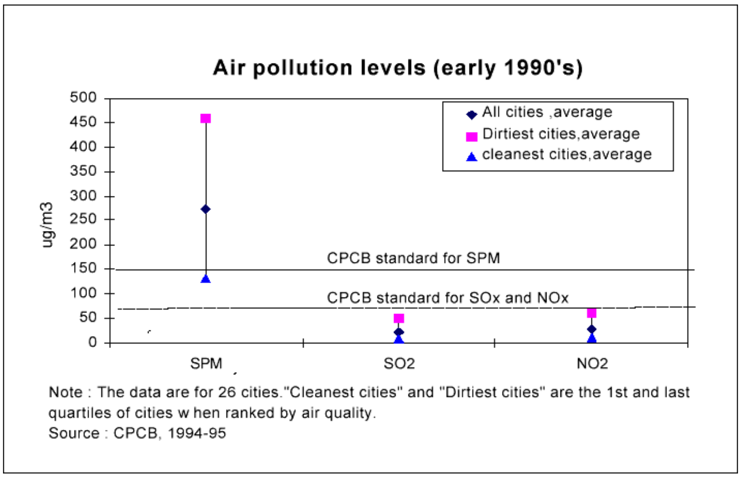


Fig 5.7 Showing Air Pollution Levels in Urban India

5.5.3 *India's Energy Policy:*

5.5.3.1 There are three points to be made that are relevant to this study. (i) The over-emphasis on supply management; (ii) tensions arising from different policies within the energy sector; and (iii) impact of subsidies.

5.5.3.2 *Supply management*: As in most developing countries the paradigm driving energy policy in India is that energy production has to be increased to industrialise, and to improve the living standards of their population. This is addressed by expanding the supply base. The emphasis was/is on thermal and hydro-electric power generation. However, recent years have seen major initiatives in renewable energy development. According to the World Watch Institute (1998) India has been recognised as a new "wind superpower' ranking fourth in the world in respect of wind power installed capacity. It has the second largest capacity to manufacture photovoltaic crystalline modules. According to Naidu (1998) India's programme of renewable energy development is reported as the second most extensive in the developing countries, next only to China. Despite these developments the focus is still on supply management.

5.5.3.3 Reddy (1998) notes that little progress has been achieved in India with regard to demand side management and end-use efficiency improvements. He argues that decision makers are still largely unfamiliar with the view that energy services, rather than consumption, should be the real objective of energy planning and programmes. Furthermore, that energy services can often be advanced equally well by demand side management and end-use efficiency improvements as by increases in supply. Mr. Sonkar, Joint Advisor - Power Sector, in the Planning Commission, agreed that little has been done at the policy level to address the question of demand management. He admitted that it was a politically sensitive issue.

5.5.3.4 International Energy Initiative, the NGO based in Bangalore, had made attempts to inform decision makers in the energy sector in Karnataka. They concluded that it is far more difficult to sell a paradigm shift than concrete projects. In their second foray they targeted a wider audience, which included politicians, other NGOs and quasi government organisations. The impact has been heightened awareness of demand side management, though little has been achieved in terms of policy. The policy emphasis at state and national levels show a pre-occupation with energy production and consumption.

5.5.3.5 *Tensions within the energy sector*: There is no single ministry at the central government level to oversee the energy sector. There are separate ministries for Power, for Petroleum and Natural Gas, for Coal and for Non-Conventional Energy Sources. The only body with an overview is the Planning Commission. It was therefore decided by this study team to meet the Energy Advisor in the Planning Commission. At a joint meeting with the Advisor's deputies in charge of power and petroleum and of coal, it emerged that while the power sector was moving ahead with de-regulation and privatisation, other sectors were slowing down the process. For example, the de-regulation of different types of coal is proceeding at different paces. This has implications for initiatives to increase efficiency of fuel use.

5.5.3.6 *Cross subsidies*: There is a complex system of cross subsidies. Petroleum has been freed up from the Administrative Price Mechanism and is linked to the international price. However, it is heavily taxed and the earnings are used to subsidise other items like kerosene and diesel. Kerosene is subsidised as a 'poor man's fuel'. The present level of subsidy is 50% and kerosene is available at government distribution shops for Rs 2-3 per litre. Over a period of time this subsidy will eventually be reduced to 15%. This will have considerable impact on poor and low income households who have shifted to kerosene as a cooking fuel.

5.5.3.7 Additional problems of comparatively cheaper diesel and kerosene are that diesel is used to adulterate petrol and kerosene is used to adulterate diesel. Both these have implications for vehicular related air pollution.

5.5.4 *Environmental Policy in India*

5.5.4.1 India was a participant of the United Nations Conference on Human Environment in 1972 which requested all attendees to adopt comprehensive legislation addressing environmental and health and safety issues. The Water (Prevention and Control of Pollution) Act was passed in 1974. The Act also established the Pollution Control Boards at central government and state government levels. The Air (Prevention and Control of Pollution) Act was passed in 1981 to provide for the prevention, control and abatement of air pollution. Following the Act, The Central Board set the national ambient air standards. In addition, the state boards were given the power to legally restrain polluters from exceeding specified standards. Subsequent to the Bhopal accident The Environment Protection Act was passed in 1986. The Act gave even greater powers to the environmental agencies and the Ministry of Environment and Forestry was designated as the lead agency for administration and enforcement.

5.5.4.2 Despite these powers, enforcement of standards have been weak, apathetic and ad-hoc. However, increasing environmental activism since the early 1990s and the spurt of legal action against deviant behaviour by individuals and NGOs have forced the environmental agencies to be more active. The response of the judiciary has been to allow limited time (often unrealistic) to make technological changes and/or to install pollution abatement equipment or face closure. The emphasis has been on end-of-pipe measures, for example, installing cyclones, bag filters, increasing the chimney stack height etc., instead of using cleaner technology and improving work practices. Furthermore, the central effluent treatment plant is seen as a panacea to the problems of industrial effluents. A case study of Delhi (Dasgupta 1998) highlighted the ad-hoc nature of the present strategy. It was observed that factories, if located in any one of the 28 industrial estates, had to contribute to the construction of a central effluent treatment plant, irrespective of the fact that they produced no effluents.

5.5.4.3 Pushing end-of-pipe measures is reinforcing a perception that industry has little to gain from improved environmental management. The UNEP's project to demonstrate the benefits of waste management to small and medium industries underscores this point (DESIRE 1996). Additionally, the sanction based approach adopted in India, limits the scope for developing network for information exchange or for developing public-private partnerships. Despite these difficulties efforts are being made by some agencies to tackle the problem in the small industries sector (discussed in Part III). Thailand has since late 1980s shifted towards a compliance-based approach, embodying the 'carrot and stick' principle (Kritiporn 1990) and has had greater success in assisting small industries to clean up.

5.5.4.4 ***To sum up***, in India the issues related to end-use fuel efficiency receive much less attention than they deserve. Though the need for demand side management has been voiced by many, little change can be observed at the policy level. The experience of developed countries shows that environmental legislation and strict monitoring for pollution abatement do not create sufficient conditions for improving energy efficiency. Dedicated programmes for enhancing energy efficiency are required.

5.6 Need for Policy Emphasis on End-Use Efficiency: Lessons from UK

5.6.1 The experience in UK has some useful lessons for end-use energy management. It highlights the importance of

- information dissemination and awareness raising;
- energy efficiency specific initiatives and advice in the initial stages; and
- energy policy initiatives receiving the support of environmental agencies.

This section briefly describes some of programme elements.

5.6.2 ***Best Practice Programme**:* In the UK, new government programmes for energy efficiency were introduced in the mid-1970s. These evolved into the Best Practice programme run by the Department of Energy. It later came under the responsibility of the Department of Trade and Industry and is currently under the Department of Environment. The Energy Technology Support Unit (ETSU) has managed it on their behalf in industry and the Building Research Energy Conservation Support Unit (BRECSU) in buildings-related areas. Projects receive financial support, energy savings and performance are monitored by independent experts, and results are published along with a range of supporting activities, including events, seminars, etc., to insure that the material is brought to the attention of appropriate decision makers.

5.6.2.1 The programme has four elements:

(i) Energy Conservation Guides, which survey energy use across a particular sector of industry on an unattributable basis. This information enables managers to compare energy use in their own site with other companies in the same business an identify areas where savings can be made.

(ii) Good Practice, which highlights energy efficient techniques already in use via Case Study Brochures and Good Practice Guides. The guides give detailed information and advice on how to implement proven energy saving measures.

(iii) New Practice, which supports 'first of a kind' projects where technology or the application is new. An independent consultant monitors projects. Leaflets and detailed reports on the results are published and distributed.

(iv) Future Practice, which supports joint ventures developing the energy efficient measures of tomorrow. Leaflets and reports on the research are freely available.

5.6.2.2 In order to promote this programme regional energy efficiency centres were also set-up. Also as the potential for industrial savings were recognised specialist commercial organisations entered the market and took over much of the promotion and execution of the programme.

5.6.3 **Environmental Programmes:** As time has gone by there have been new energy saving initiatives with increasing environmental support for such work. In 1992, the Department of Environment, Transport and Regions created the Energy Savings Trust. This was set up with a brief to reduce carbon emissions by 10 M tonne/year. There has also been legislation in this area with the passing of the Home Energy Conservation Act in 1995 so that now local authorities have responsibilities for energy performance of all housing in their areas. This has resulted in many local centres for advice particularly on domestic energy saving. There are also NGO organisations that are active, including the National Energy Foundation and the Association for the Conservation of Energy.

5.6.3.1 The overall picture has been that awareness in the industrial scene was created to the extent that there was a high level of commercial activity that took this forward under business energy management schemes. This has resulted in the creation of so-called energy service companies, ESCOs and a relatively lower level of government funding. By contrast, in the domestic area, whilst the support mechanisms from government encourage commercial involvement there is an expectation that government support in this sector needs to increase. However there is an active debate on the level and manner of investment that is necessary to achieve the impact that is sought. This has been highlighted by the need to meet Kyoto targets and it is recognised that this will require a strategy across the whole economy.

5.6.4 **EC and Other Programmes:** In parallel to this UK activity there have been an increasing number of EC based schemes that support energy efficiency. In the industrial sector one notable example has been the THERMIE programme which supports demonstration projects for rationale use of energy. In addition there are other active EC organisations, most notably the extensive OPET Network (Organisations for Promotion of Energy Technologies). The UK participates and benefits in these activities through its membership in the EU. The UK also is involved in an information dissemination scheme, CADDETT, which is run through the International Energy Agency. This is now available on the Internet and, increasingly, information for all promotion mechanisms will now be made accessible in this manner.

5.6.5 **Relevance of UK Programmes to Developing Countries***:* Any attempts at transposing the experience of the UK or other developed countries to developing countries will need to be done with due regard to the current situations and capabilities in those countries. The developmental processes for transfer in different industrial sectors and domestic sectors may not be amenable to the same approach. In India, the very large scale of small to medium scale enterprises organisations is unique and will present a particular challenge. There will need to be assessment in partnership with participating professional workers in these countries.

PART II

THE HOUSEHOLD SECTOR

6. HOUSEHOLD FUEL USE AND POVERTY IMPACTS

6.1 Introduction

6.1.1 Part II focuses on the links between energy use in the domestic sector and poverty. These links are examined within the analytical framework of the integrated development approach. Efforts to design and introduce improved cooking stoves for rural and urban use are long-standing. There have been a large number of stove programmes in many different countries in Asia and Africa, which go back several decades. While these programs have included the promotion of improved stoves using a range of different fuels, the focus has tended to be on biomass fuels and in particular wood stoves. The experiences of these programmes have also been relatively well documented, and considerable efforts have been made to analyse reasons for success or failure of different projects. Lessons learnt have been brought together in a number of practical guidelines, which provide guidance on approaches to appraisal, design, testing, evaluation and dissemination of stoves. There is a wealth of knowledge and documentation on stove programmes on which Part II has been able to draw.

6.1.2 In addition to the review of the extensive literature, a case study which included one week of in-country fact finding was conducted on the domestic energy sector in urban areas in India, with a focus on Delhi and Calcutta. This was seen as a valuable part of the research, since it permitted the exploration of a particular situation in more depth. It also enabled collection of up-to-date information and analyses on the urban domestic energy situation and current initiatives in India from literature not available in the UK. Findings from the case study indicated that the situation in Delhi was in some ways typical of the big metropolises and other mega-cities with respect to domestic energy characteristics because a high proportion of commercial fuels (kerosene, LPG) are used. Saxena *et al* (1996) estimates that commercial energy accounts for 53% of energy use by lower income groups in urban India. In Delhi slums, this figure varied between 56% and 67% (TERI: 1993). A number of useful lessons can be drawn from the case study findings that are of general relevance to domestic energy policy for the urban poor. It has been possible to draw up a number of preliminary recommendations for future (DFID) urban domestic sector initiatives in India.

6.1.3 This chapter explores links between energy and poverty at the household level. It first describes the pattern and trends in energy use and supply. It examines energy-poverty links within the integrated development approach and then assesses how improvements in energy efficiency can benefit poor households.

6.1.4 Chapter 7 looks at India in more detail. It analyses the characteristic of the poor households in the slums; notes the types of fuel use and the shift up the energy ladder; and concludes with a critique of government policies affecting energy use by the urban poor.

6.1.5 Chapter 8 looks at the problems associated with energy use in poor urban households, and the range of options for addressing these problems. Improved energy efficiency measures constitute one set of options. Although there is considerable variation in types of fuel used, and despite the general shift towards petroleum-based fuels, many poor households still rely heavily on biomass fuels as a source of energy for cooking, heating and light. Given this situation, two key strategies for improving energy efficiency are (i) the introduction of improved biomass stoves, and (ii) the encouragement of a switch to more heat-efficient fuels (moving up the “energy ladder”). These two options are therefore addressed in some detail, with a review of the advantages, disadvantages, and key lessons learnt from past experiences of fuel-switching and urban stove programmes.

6.1.6 For a short study of this nature, it was difficult to provide more than a cursory overview of the knowledge base, and the risk of duplicating existing work was also recognised. With these constraints in mind, this chapter has been structured to provide a clear "guide" of the key documents and institutions with expertise in the area, rather than to go into detail on any one issue. Two essential sections are therefore **section 8.6 giving "Key References and Contacts" and Appendix A which provides Guidelines for Designing, Developing, Monitoring and Evaluating Household Energy Interventions.**

6.2 The Problems: Links between Energy and Poverty at the Household Level

6.2.1 The urban poor and household energy use: setting the scene

6.2.1.1 The *household sector* accounts for a large proportion of *energy consumption* in developing countries, compared to industrialised countries, with the domestic sector accounting for over 75% of total energy consumption in some African countries (Gopalan: 1990). Domestic consumption accounts for 39% of total consumption in India. Most of the energy consumed is used for *cooking,* followed by space heating/cooling and lighting. Table 6.1 gives a break-down of household fuel use and shows the variation in fuel use with economic groups in Pakistan.

6.2.1.2 On the supply side, household fuel sources in many developing countries are still characterised by the *dominance of biomass fuels* (wood, crop residues and animal droppings, often referred to as non-commercial fuel). While middle and higher income groups in urban areas and affluent households in rural areas are more likely to use more efficient, non-traditional fuels such as kerosene and liquid petroleum gas (LPG) for cooking, and electricity for lighting, the majority of the rural population and lower income groups in urban areas still rely heavily on biomass fuels. A study in Zimbabwe considered that wood was likely to remain the fuel choice of the poorest urban sector as they obtain wood through collecting rather than purchase. Urban poor people will only switch to other fuels when the opportunity costs of collection becomes too high, when deforestation is much further advanced or when their income levels rise (Campbell and Mangono: 1994). In India this has already started to occur. A survey conducted by the National Council of Applied Economic Research (NCAER: 1985) to compare fuel use by different income groups in urban areas showed that in 1977/78 66% of fuel consumption in the lowest income group was from biomass fuels, compared to just over 15% in the highest income group. By 1992 the situation had changed with non-commercial energy meeting just over 47% of fuel consumption by the lowest income group and 2.5% in the highest income group (TERI: 1993).

Table 6.1 Fuels Used by Poor and Rich Households (HH) in Pakistan for Various Purposes.

Fuels and Uses	**% of Poor HH**	**% of Rich HH**
Cooking		
Gas (Natural Gas/LPG)	3.1	36.4
Electricity	0.0	2.3
Kerosene	6.7	18.7
Charcoal and Coal		
Biomass Fuels	91.4	60.9
Cooking inside the house	34.3	27.8
Inside with no chimney	87.9	74.6
Space Heating		
Gas (Natural Gas/LPG)	0.1	3.8
Electricity	0.1	4.4
Kerosene	0.7	0.5
Biomass Fuels	27.4	19.6
Water Heating		
Gas (Natural Gas/LPG)	2.3	22.4
Electricity	0.0	1.6
Kerosene	1.4	5.6
Biomass Fuels	23.0	25.9
Lighting		
Electricity	57.4	80.9
Kerosene	81.2	55.5

1. Biomass is wood, dung, wheat, straw, coconut shell, cotton sticks, rice hull, corn husk, bagasse, tobacco husk and other biomass.

2. Poor households are households in the lowest quintile of the distribution of household expenditure (1st quintile). Rich households are households in the highest quintile of the distribution of household expenditure (5th quintile).

Source: (Pakistan LSMS, 1991) in Energy After Rio: Prospects and Challenges, UNDP (1995)

Table 6.2 Pattern of Fuel Consumption by Urban Income Groups in India

	1977/78		**1992**	
Income group	**Commercial (%)**	**Non-commercial (%)**	**Commercial (%)**	**Non-commercial (%)**
Up to Rs. 3,000/ month	33.9	66.1	52.8	47.2
Rs. 3,000-Rs. 6,000/month	55.0	45.1	92.5	7.5
More than Rs. 6,000/month	72.2	27.8	97.5	2.5

Source: NCAER: 1985; TERI: 1993

6.2.1.3 There are however, a number of important differences in fuel use between the urban poor and their rural counterparts. In the first place, whereas crop and animal residues are important fuel sources in rural areas, *fuelwood is the predominant biomass fuel used by urban households*. For example, fuelwood accounted for nearly 47% of all fuel used in the domestic sector in urban areas of India by the poorest income groups in 1992 (TERI: 1993). Moreover, urban households are much more likely to purchase their fuels compared to their rural counterparts, including biomass fuels, which means that urban households tend to incur a financial rather than a labour cost for fuel. For example, the NCAER Domestic Fuel Survey showed that whereas most rural households collect rather than purchase their fuel (only 20% of fuel used is purchased), 93% of fuels used by urban households are purchased (NCAER: 1985).

6.2.1.4 The urban poor are also more likely to use some form of stove rather than an open fire for biomass fuels, probably due to greater availability of stoves and more confined spaces in urban areas compared to rural areas. The urban poor are also more likely to buy rather than construct their own stoves.

6.2.1.5 The urban poor theoretically have better access to alternative fuels and stoves/appliances than their rural counterparts. There are however often a number of constraints for the poor to access these alternatives in practice, which relate to the ways in which poverty *per se* can constrain poor people's ability to improve their energy use. These include:

- Poor residential areas tend to have the worst infrastructure, including electricity, and retail outlets for fuels such as gas or kerosene;
- Where poor areas do have access to e.g. electricity, supplies tend to be unreliable, with priority given to other areas in times of supply scarcity;
- Appliances (e.g. stoves, electrical wiring, gas cylinders) for fuels further up the energy ladder require higher initial capital investment, and this is often enough to act as a barrier to entry for poor people;
- Appliances with greater efficiency at performing specific tasks e.g. lighting, or cooking, tend also to be more specialised, implying that more appliances are needed to perform the range of required functions (cooking, space heating, lighting etc.);
- Fuelwood tends to be sold on the informal market in small quantities, whereas other fuels tend to be sold in larger quantities through more formal outlets. The former are more easily accessible by the poor than the latter (Munslow *et al*: 1988).

6.2.1.6 Of course, factors governing fuel use vary from place to place, and some of these constraints can be reduced through appropriate policies. For example, types of fuels used depend to a significant extent on what is available locally. Census 1991 noted that in West Bengal and Bihar, in India, coal was the primary domestic fuel at 55% and 46% respectively, reflecting the presence of coal mining in the vicinity. Discussions in India during the fact finding visit revealed that this pattern may have changed considerably due increased price of coal.

6.2.1.7 In addition to the supply and demand trends in domestic fuel use, the proportionate share of fuel in household expenditure has considerable implications for energy efficiency initiatives. As Table 6.3 shows the urban poor in Pakistan spends 8.4% of their expenditure on fuel. For all poor households, the figure stands at 5.4%. No break down is given for fuel expenditure in terms of cooking and other activities. Even if it is assumed that 75% of this fuel expenditure is on cooking fuel, increase in energy efficiency will produce marginal gains in the disposable income of the poor. Traditional wood stove has an efficiency of about 18% and costs nothing. Improved wood stove has an efficiency of ~29% and cost $6-7. Improved stoves will give a maximum saving of 38% on the fuel bill. This is quite substantial as it also implies a comparable reduction in mass of pollutant generated. However, this amounts to a maximum saving of 2.4% of the total expenditure of poor urban households. These relationships should be more closely examined in the project design stage to ascertain the economic benefits that could be generated by a initiative.

Table 6.3 Household Expenditure Shares by Quintile in Pakistan

	Total Population		Urban Population	
	1st Quintile	**5th Quintile**	**1st Quintile**	**5th Quintile**
Food	57.5	29.1	51.5	25.6
Housing	9.6	13.6	14.9	19.0
Clothing	8.4	5.3	6.8	5.4
Health	6.8	9.8	5.8	7.7
Fuel	5.4	22.2	8.4	20.3
Education	2.7	3.4	3.9	4.5
Transport	0.8	1.8	0.8	2.3
Other Expenditures	8.8	14.4	7.9	15.1
Total	100.0	100.0	100.0	100.0

The financial advantages of improved stoves will depend on many factors including:

- Efficiencies of the traditional stove in a particular country, Higher the efficiency of the traditional stoves, less attractive improved stoves will be. Traditional Indian *chula* is a relatively efficient device;
- Cost of improved stove. This in turn is determined by labour costs, maintenance costs and replacement periods;
- Efficiency of improved design; and
- Cost of fuelwood.

6.2.1.8 In the case of India where efficiency of traditional stoves for fuelwood is already relatively high, initiatives for improving stove design should be carefully evaluated.

6.3 The Conceptual Framework

6.3.1 Part III investigates the links between poverty and inefficient energy use in the industrial sector. A key issue in strategies to improve efficiency in industries is the division between those who make decisions about energy use (owners and managers of factories), and those who bear many of the costs of inefficiency (workers, and households in poor residential areas near factories).

6.3.1.1 In contrast, in the domestic sector the links between energy use and poverty are more direct. This is because household members are at the same time making decisions about what fuels and appliances they use, and bearing many of the costs and benefits of these decisions.

6.3.1.2 One aspect of these more direct links between energy use and poverty at the household level is that these links work in both directions. On the one hand, inefficient energy use, when coupled with fuel scarcity, can exacerbate the livelihood security of poor people in urban areas, in a number of ways. On the other hand, the poverty of people tends to prevent them from using more efficient fuels and appliances. As represented in the integrated development approach to poverty (see Section 2.2.10), poverty has many contributing factors, many of which cannot be addressed by tackling energy problems alone. Thus, measures to improve energy efficiency can help to alleviate certain problems associated with its use, but such measures, however well designed and targeted, will not have a significant impact on reducing poverty unless they are part of a wider, integrated programme aimed at tackling the determinants of poverty.

6.3.1.3 Moreover, in order to realise the potential poverty impacts of measures to improve energy efficiency, it is essential to recognise that improved energy efficiency is not a developmental aim in itself, *but rather a means of achieving a range of different developmental objectives.* These include improved nutritional status, reduced risk of respiratory and skin diseases, increased income, reduced costs of living, reduced drudgery due to less time spent on collecting fuelwood, increased chances of education. In order for improved energy efficiency initiatives to have a poverty impact, they need to consciously target the developmental objectives of poor people. Furthermore, it needs to be explicitly recognised that there are circumstances where efficiency measures will not be an appropriate tool to apply, and that energy efficiency measures will have different developmental or poverty impacts in different situations. If energy efficiency measures are to have a real impact on poverty, the developmental objectives of the target groups of poor people need to be clearly defined from the outset., The "success" of interventions needs to be based on the extent to which they meet these *developmental* objectives. The evaluation of energy efficiency interventions, such as improved stove programmes, have in the past tended to focus on improvements in technical efficiency and mass adoption rates. It is important to recognise that neither of these measures *per se,* are indicators of success in terms of poverty impact.

6.3.1.4 The measures of poverty impact could be (i) the savings in the fuel bill following the use of improved stoves; (ii) proportion of low income group to total number of new adoptees; (iii) proportion of stoves in use among the poor after measuring the drop-out rate; and (iv) the extent to which the expected benefits, as defined by the target group, are met.

6.3.1.5 It is therefore important to broaden the scope of the discussion, from looking at links between energy efficiency and poverty *per se,* to investigating the range of developmental problems that energy efficiency initiatives aim to address. A review of development programmes aimed at improving household energy efficiency reveals a range of developmental objectives. These can be divided into those that aim to alleviate problems associated with *fuel scarcity* on the one hand, and those that wish to reduce *health impacts of pollution from inefficient combustion* on the other. The reason for separating these two categories of impacts is that each category has a different range of potential management options associated with it, as presented in Chapter 8. We will investigate each of these categories in turn.

6.3.2 Poverty impacts of fuel scarcity

6.3.2.1 The are a range of poverty impacts associated with fuel scarcity and/or high costs of obtaining fuel. These are reviewed briefly below.

1. Financial costs

6.3.2.2 Poor people tend to spend a larger proportion of their incomes on fuel than do wealthier households, which reflects the tendency for poorer people to spend relatively more on meeting "basic needs". In India, for example, results from the National Sample Survey (38^{th} Round) 1983-84 showed that in urban areas, whereas the wealthiest of six expenditure groups spent only 4% of their disposable income on fuel and lighting, the lowest expenditure group spent 12% of their income on meeting the same needs (Gopalan: 1990). In Pakistan the pattern seems the reverse (Table 6.3). Another reason why is that they tend to pay higher costs per unit energy, both because they use less efficient fuels, and because their limited cash resources at any one time means that they tend to be restricted to buying small amounts of fuel frequently, which usually incurs higher per unit costs. The financial costs of fuel are further exacerbated where increasing fuel scarcity or other factors are leading to high rates of inflation in fuel prices. Overall expenditure on energy tends to increase, however, as incomes rise (TERI: 1993).

2. Labour costs

6.3.2.3 Large amounts of time and energy spent on collecting biomass fuels is often seen as a key problem that can be addressed by improved domestic energy efficiency. In most cultures these costs tend to be borne disproportionately by women and children. However, in urban areas fuel costs are generally financial rather than labour costs, so this is less of a critical issue in terms of the parameters of this study.

3. Health costs

6.3.2.4 Fuel scarcity can lead to a number of household coping strategies which may threaten hygiene and nutritional standards in the home, which can lead to deterioration in the health of household members. In terms of *nutritional status*, household responses to fuel scarcity may include any of: reduced cooking times, re-heating of leftovers, switching to quicker cooking but less nutritious foods, and/or switching to more expensive pre-prepared/cooked foods. Any of these strategies may lead to a deterioration of the nutritional status of some or all household members. In societies like India, studies have shown that women and female children are most likely to bear the costs of such coping strategies. Fuel scarcity may also lead to a fall in levels of *hygiene* due to drinking water not being boiled, or washing water not being heated, which can both increase health risks.

4. Security costs

6.3.2.5 There a number of reports which show that the risk of rape or other assault is considered an important cost by women and children who have to travel far to secluded woodlots etc. to collect their fuelwood (see e.g. Lugemwa: 1992, in Boiling Point Issue 27). However, again, this issue may be less relevant for urban households, since they tend to buy rather than collect their fuel or collect wood from more public places

6.3.3 <u>Health problems associated with inefficient combustion of fuels</u>

6.3.3.1 Inefficient combustion leads to a larger range and concentration of pollutants in smoke, which can cause a range of serious health problems. Moreover, women, children and old people tend to suffer the most from these health problems, since they spend the most time indoors, and near the fire or stove. The significance of health impacts due to pollution from domestic stoves and fires is underpinned by evidence from some studies that health risks from indoor air pollution are much higher than those from outdoor pollution (see e.g. Smith: 1991). A recent study has shown a link between pollution from indoor-cooking by the poor and some health problems (Sharma *et al* , 1998). The range of possible health impacts of pollutants from inefficient combustion of biomass fuels are summarised in Table 6.4 below. However, it is pertinent to note that in certain countries a majority of woodfuel user cook outdoors. For example, these figures stands at 66% in Pakistan and 67% in India. Those cooking indoors are likely to be concentrated in colder regions.

Table 6.4 Summarising the Health Effects of Biomass Fuel Use in Cooking

Processes	Potential Health Hazards
PRODUCTION	
Processing/preparing dung cakes	Faecal/oral/enteric infections; skin infections
Charcoal production	CO/smoke poisoning; burns/trauma; cataract
COLLECTION	
Gathering/carrying fuelwood	Trauma; reduced infant/child care Bites from venomous reptiles/insects Allergic reactions; fungus infections Severe fatigue; muscular pain/back pain/arthritis
COMBUSTION	
Effects of smoke	Conjunctivitis. Blepharo conjunctivitis; Upper respiratory irritation/inflammation Acute respiratory infection (ARD)
Effects of toxic gases (CO)	Acute poisoning
Effects of chronic smoke inhalation	Chronic Obstructive Pulmonary disease (COPD) Chronic bronchitis Cor Pulmonale Adverse reproductive outcomes Cancer (lung)
Effects of heat	Burns; cataract
Ergonomic effects of crouching over stove	Arthritis Burns in infants/toddlers
Effects of location of stove (on floor)	

Source: Based on data given in World Health Organisation: Indoor Air Pollution from Biomass Fuel (1992), quoted in UNDP: 1996.

6.3.3.2 More solid data is needed on the effect of this type of pollution on poverty and health. With a 'value' attached to it, pollution from cooking can be ranked and judged against other causes of illness such as poor diet, poor housing, poor sanitation and poor education. Without such a ranking there is great risk that scarce resources will be allocated to inappropriate developmental effort.

6.3.3.3 The rationale for health benefits of improved stoves is that (i) pollution from traditional stoves is bad for health; and (ii) improved stoves use less fuel and produce lower emissions and therefore are better for health.

6.3.3.4 The following considerations need to be addressed for this rationale to be valid and justifiable:

- The main pollutants, detrimental to health, from fuelwood-stoves are, smoke and soot, carbon monoxide, polyaromatic hydrocarbons - PAH - (these mainly exist as adsorbed compounds on soot particles).

- PAH are a class of compounds, many members of which are known potent carcinogens in small concentration. There is no evidence that improved stoves reduce these compounds to levels at which the hazard posed by these compounds is significantly reduced. Data to define minimum exposure limits is essential before judgements can made if improved stoves really do reduce health risks posed by these compounds. Another issue is whether the PAH compounds produced in traditional and improved stoves are the same. Not all PAH compounds are carcinogenic and not all PAH compounds are equally potent. As the combustion parameters in traditional and improved stoves are different, the types and concentrations of PAH compounds produced in two types of stoves are likely to be different.
- Carbon monoxide is a toxin and reduces ability of the blood to carry oxygen. Some of the improved stoves rely on close matching of the stove to the pot design for proper operation. A mismatch results in the situation where inadequate amount of air is supplied to the fire. This results in more carbon monoxide being produced compared to the traditional stoves (Energy After Rio: Prospects and Challenges, UNDP ,1995).
- As shown before, the maximum fuel saving which can be expected is of the order of 38%. What is the impact of this reduction on health?
- In assessing the impact of enhanced efficiency, consideration has to be given to whether cooking is conducted indoors or outdoors. For people cooking outdoors, pollution is relatively freely dispersed and diluted. It will be more problematic to relate enhanced efficiency and health benefits.

6.4 The Poverty Impacts of Fuel Scarcity and Inefficient Combustion

6.4.1.1 As mentioned above, there are a different range of management options for tackling the poverty impacts of fuel scarcity on the one hand, and inefficient combustion on the other. For both of these, improving energy efficiency represents only one of a range of management options.

6.4.2 <u>Options for Addressing Fuel Scarcity</u>

6.4.2.1 This section draws largely on an overview of urban energy options presented in Munslow *et al*: 1998.

1. Supply enhancement

6.4.2.2 This is an obvious option to consider in order to tackle problems associated with fuel scarcity, and this has often been the focus of energy policies in the past, including that of the Indian government. In terms of fuelwood, Munslow et al consider there to be five main options for enhancing urban supply. These are: expansion of peri-urban plantations, improved management of natural woodlands, encouragement of planting of wood for fuel on farms, and improved utilisation of wood waste products from other production activities. While there are constraints to this approach, it is important to recognise it as an alternative or complementary approach to improving energy efficiency as a means of tackling poverty impacts of fuel scarcity.

2. Improving marketing and transport

6.4.2.3 Improving the efficiency of marketing and transport (distribution) of fuels may help to tackle some of the problems associated with fuel scarcity, by reducing the end cost of fuels to poor households and improving reliability of supply. In relation to fuelwood distribution, Munslow et al argue that fuelwood distribution chains are often long, and their efficiency could be improved to the benefit of end users. In India, fuelwood purchased by urban households tend to be distributed via centralised urban fuelwood depots (Gopalan: 1988), which may mean that there is less opportunity for reducing costs. However, improved marketing and transport is an area that could be further investigated for wood and other fuels in India during the next phase of the study.

3. Fuel Switching (moving up the energy ladder)

6.4.2.4 This option, which involves improving energy efficiency, is addressed in Section 8.5.

4. Improving efficiency of fuel use through more efficient stoves

6.4.2.5 This option is also addressed in more detail below in Section 8.4.

5 Changes in household practices

6.4.2.6 There are a number of improvements that could be made to household practices relating to fuel use, that would also lead to more efficient use of energy sources. These include: changes in fuel preparation methods, e.g. people living in dry areas sometimes sprinkle water onto dry firewood to reduce its rate of burning; improved fire management practices, e.g., use of windbreaks, shielding the fire, using the same fire for a range of purposes at the same time, adjusting distance between the pot and stove/fire etc.; changes in food preparation techniques, e.g. pre-soaking of beans, cutting food into smaller pieces; and changes in cooking practices, e.g. use of better lids, placing stones on lids to add more pressure (Nelson: 1996).

6.4.3 Options for addressing the health impacts of pollution due to inefficient combustion

1. Diverting the smoke

6.4.3.1 An alternative to reducing pollutants is to divert the pollution away from where it causes most damage. Methods for reducing smoke levels where it matters include cooking outdoors, use of (improved) chimneys, use of stove hoods, and improving ventilation of dwelling areas (Boiling Point Issue 34).

2. Improving burn efficiency of stoves

6.4.3.2 This option is addressed under Section 8.2 on Improved Stoves.

6.5 Conclusions and Findings

6.5.1 Improving energy efficiency can be an effective way of tackling problems associated with both inefficient combustion and scarce fuel supply, but it is important to recognise that there are alternative approaches that may be more appropriate in some circumstances. Due to the focus of this study, the rest of Part II concentrates on those management options which involve improving energy efficiency, namely improved stoves and switching to more efficient fuels. Chapter 7 first provides a more detailed picture of energy use, trends and policies in India.

6.5.2 Based on the discussions above the findings of this chapter are:

1. **Benefits of enhanced energy efficiency at the household level could be in terms of increased disposable income and improved health following reduction in pollution. Therefore, measures of poverty impact could be savings in fuel bills; proportion of uptake by poor households; proportion in use after measuring drop-out rate; and range of expected benefits generated, as defined by the target group.**

2. **Enhanced efficiency leading to reduced fuel needs will reduce the mass of pollutants generated. This will have health impact only if cooking is undertaken indoors.**

3. **There has to be careful evaluation at project design stage of levels of economic benefits that could accrue in terms of disposable income from enhanced energy efficiency.**

4. **It is important to define minimum exposure limits before judgement can be made if improved stoves do really do reduce health risks posed by PAH class of compounds.**

5. **In cases where efficiency of traditional stoves for fuelwood is already relatively high, initiatives for improving stove design should be carefully evaluated**.

7. HOUSEHOLD ENERGY USE AND URBAN POOR IN INDIA

7.1 Introduction

7.1.1 This chapter first describes the characteristics of households in the slums. Based on secondary review and on in-country fact finding mission, it then defines the trends and patterns in urban household fuel use. It concludes with a discussion of government initiatives affecting energy use of the urban poor.

7.2 Characteristics of Slum Dwellers

7.2.1 Up to 50% of the urban population are estimated to live in sub-standard, slum areas. These are defined as any structure, group of structures or area unfit for human habitation due to deficiencies in the nature of the accommodation and/or the environment. While this covers a huge number of people (the urban population is expected to reach 300m by 2,000) not all slum dwellers are the poorest people. Such is the shortage of housing in the big cities that government employees such as policemen are forced to live in slum housing (Times of India, 18.7.98) and ownership of refrigerators and televisions by slum dwellers are common. However, there is considerable heterogeneity in household incomes.

7.2.2 Differentiation of slum types also exist, with the poorest families generally living in the least supported slums. Government-recognised slums are provided with services such latrines, water, community centres and housing loans. The non-recognised areas, generally more recently settled, are not provided with services and tend to be ignored. These are known as *Jhuggi jhopri* (JJ) clusters (groups of 10 or more temporary physical structures used for living or other purposes and made of straw, mud, loose bricks, tin, wood, corrugated sheets etc. without adequate foundations). They tend to be the poorest areas, due to their poor socio-economic conditions combined with maximum size increase. These areas are overcrowded, with poor or no sanitation and in the larger camps there are no open spaces between long rows of dwellings. Many people may live in one room which are poorly ventilated, often with only a door and many household and business activities spill out into the narrow lanes. There is a mix of caste, class (though predominantly lower social and economic), place of origin and education among slum dwellers. In addition to low incomes and lack of access to support services life is made harder through the prevalence of drugs, alcohol and prostitution and exposure to diseases such as TB and cholera.

7.2.3 Most of the family units are nuclear. Some men have permanent jobs while others depend on casual work, as cleaners, on building sites but generally in the informal sector. A few women work, depending on circumstances and their place of origin, some as domestic servants, some on construction sites and others in small-scale production and vending. The position and status of women is “complicated and confused” depending on their exposure, interaction and autonomy (NCAER, 1988). Women from southern India are often more educated and freer to work outside the home and earn an income. Household incomes are estimated to vary between Rs. 500 and Rs. 3,000 per month (R. Uma, personal communication). A labourer receives Rs. 50-60/day (= Rs.1,100-1,600/month). The government’s poverty income criteria for urban areas is Rs. 1,975 per month (Economic Survey 1997) so few families are living much above the poverty line.

7.3 What Types of Fuel are being Used by the Urban Poor, Including What Variation There is and Why?

7.3.1 The main type of fuel used for cooking by the urban poor is kerosene (paraffin). Two types of stoves are available – a pressurised jet stove and a wick stove (which both need protection from the wind). All families living in recognised areas are entitled to a ration card which authorises them to a subsidised monthly quantity of kerosene of 12 litres per person. The subsidised price of kerosene is Rs. 32 for 12 litres (i.e., Rs. 2.67/litre). However, not all poor people have ration cards and they are forced to pay the open market price of Rs. 10-12 per litre. Average monthly household consumption of kerosene for cooking was found to range between just under 16 litres to nearly 19 litres in a study of Delhi poor households (TERI: 1993). During a field visit to one JJ cluster in Delhi the residents estimated that of 55 households, 50 use kerosene.

7.3.2 Some people living in the JJ clusters use LPG. In a larger, older cluster around 20% of households were said to use LPG. It is preferred because it is associated with a better lifestyle and it is safer and easier to use (kerosene is smelly to use). The cost of LPG gas is similar to the cost of subsidised kerosene but establishment costs are higher and there are obstacles to obtaining the right to access. The deposit for a gas cylinder is between Rs. 2,000 and Rs. 3,000. Applicants also need a ration card.

7.3.3 In a survey of more than 8,000 households over 97 JJ clusters in the 5 zones in Delhi, it was found that kerosene was most widely used, in the range of 56% of total fuel use to 67% between zones. The next most widely used fuel is wood, with between 20% to 26% of households in the five zones using it (TERI: 1993). Wood is used as a subsidiary fuel to cook particular foods, such as bread. In a survey carried out ten years' ago women from northern areas said they cooked on wood as their husbands preferred the taste of food cooked in that way. New arrivals from the countryside are also likely to use wood, which they scavenge from parks and avenue trees, as they may be unused to using kerosene and not have the money to pay for it.

7.3.4 Lack of space for constructing *Chulha*s (stoves), and fear of causing fires in the densely populated slums inhibits the widespread use of wood for cooking. There is also limited space for storing biomass fuels. However, a study conducted by TERI (Saxena *et al*: 1996) found there may be cultural preferences associated with the use of particular fuels. In one slum area where residents had access to subsidised kerosene via their ration card Muslims and people from Rajasthan preferred to use wood for cooking. It is interesting to note, from Table 7.1 that ten per cent of households without ration cards do use kerosene.

Table 7.1 Relationship between Ration Card Possession and Fuel Used

Fuel	**Percentage of houses with ration card**	
	Yes	No
Wood	95.6	4.4
Kerosene	89.2	10.8

Source: Saxena *et al:* 1996

7.3.5 Many slum households, even in the JJ clusters, have electricity connections. Few of these connections are legal i.e. the electricity is unpaid for. The government has launched a special campaign in Delhi to grant electrical connections to the residents of JJ clusters for a nominal rate of Rs. 10. Electricity is used mainly for lighting, heating and cooling air (fans), and entertainment (television, audio systems).

7.3.6 Detailed information on changes in the cost of fuel over time was not obtained. Anecdotal evidence indicates that the price of fuelwood in the cities has become increasingly expensive and a report by TERI (1993) indicated that the price of wood increased by nearly 400% between 1983 and 1985. However, a study of average urban woodfuel prices between 1989 and 1997 shows an increase from Rs. 1/kg to Rs. 1.93/kg over the nine-year period – a rise lower than the rise in wholesale price index (Agarwal: 1998).

7.3.7 Studies have shown that household energy consumption is positively correlated with income and that increasing urbanisation and growing energy demand are closely linked. In 1977/78, firewood met more than half of the gross needs of urban homes. During the period 1982/83 to 1987/88, there was a steady shift from non-commercial to commercial sources of energy in urban homes. In Delhi, the share of kerosene and LPG increased, from 34.9% to 44.5% while fuelwood fell from 42% to 27% (TERI: 1993).

7.3.8 As noted in chapter 5, the government is under pressure to reduce subsidies on fuels, including kerosene, over the next few years. The reduction in the subsidy on kerosene, from 50% to 15% could have a dramatic impact on energy consumption and household welfare.

Table 7.2 below gives indicative prices for the three main domestic fuels. It is important to note that in some instances it can be cheaper to use LPG than wood. Information on the useful energy, which takes into account the efficiency of the cooking device, delivered by firewood, kerosene and LPG, would further highlight the differences in cost.

Table 7.2 Relative Fuel Prices and Typical Domestic Daily Fuel Consumption (December 1998)

	Unit cost	**Amount used (per household)**	**Household cost/day**	**Start-up cost**
Wood	Rs. 1 - 2/kg	2-3 kg/day	Rs. 2 – 6/day	Some wood scavenged – no financial cost
Kerosene - subsidised	Rs. 2.7/litre	1 – 1.6 litre/day	Rs 2.7 – Rs. 4.3/day	Stove
- open market	Rs. 10 – 12/litre	1 – 1.6 litre/day	Rs. 10-20/day	Stove
LPG	Rs. 140/refill	1 refill lasts 20-40 days	Rs. 3.5-7/day	Hobs and Cylinder Rs. 2-3,000
	Small gas cylinders said to be available Rs. 50-60/refill	Last 7-8 days.	Rs. 6.25-7.5	Not known

Source: Field notes: December 1998.

7.4 Government Policies and Programmes Affecting Energy Use by the Urban Poor

7.4.1 There are three main policies areas which have affected energy use by the poor. These are (i) the national government's policy on subsidy; (ii) the National Programme for Improved *Chulhas* (NPIC)*;* and (iii) lack of an integrated management policy for domestic fuel use by urban poor. Each of these are discussed below.

7.4.2 *Subsidy on kerosene:* The main programme benefiting the urban poor has been the subsidisation of kerosene and its availability through the Public Distribution Service. However, people complain of cheating by ration shop dealers. They allege that most of the time kerosene is not available at ration shops, forcing people to buy it on the open market, where the price is much higher Table 7.2). A shortage of kerosene may force people to use other fuels such as firewood, which is expensive to buy, or dung cakes (TERI: 1993). LPG is also subsidised.

7.4.3 *The National Programme of Improved Chulha*: It has received considerable support from the government, has been targeted at rural, rather than, urban areas. The improved *Chulha* programme was introduced on a demonstration scale in 1981/82, and developed into a national programme in 1984, by the Department for Non-conventional Energy Sources (now a Ministry- MNES) in response to concerns about deforestation and shortages of fuelwood.

> "Major efforts under the NPIC were made in improving the thermal efficiency of the cookstoves so as to reduce fuel consumption.... The environmental concerns were only secondary. However, the models propagated under NPIC were kitchen friendly - they reduced the indoor pollution load".
> Source: Environmental hazards of chimney-less stoves, S. K. Sharma, Director, Energy Research Centre, Chandigarh.

7.4.4 Seventeen regional energy support organisations, Technical Back-up Units (TBUs), have been established and considerable input has gone into developing improved biomass stoves (some 30-40 improved stoves, metal and ceramic which use twigs, dung, crop residues have been developed) although the main model disseminated is a mud-clad, pottery lined, fixed stove with a chimney. There has been considerable testing of improved stoves under laboratory conditions (where efficiencies of 20-30% have been obtained but no systematic method has been evolved for testing in domestic conditions). TBUs monitor performance under household conditions for a year.

7.4.5 The National Programme of Improved *Chulha*s covers (a) Research & Development; and (b) funds state governments to implement the programme via nodal agencies. Different states receive different amounts for their improved *Chulha* programme from the MNES, depending on population, area, and state target. Some states already support improved *Chulha* programmes from their own funds. The federal government wants to end its financial input into the programme. By the end of 9th or 10th Plan, state governments will have to support their own programmes as support from the MNES is likely to be phased out.

7.4.6 The dissemination programme includes three types of training:

- training to self-employed (mainly women) workers (SEW) on stove construction (10 days);

- entrepreneurship training is also given whereby entrepreneurs (blacksmiths, potters) are trained to manufacture metal stoves and stove components; and
- users' training programme - 1/2 day training in villages by community workers/NGOs/Government agents for users on how to use, carry out day-to-day maintenance. Some courses use video programmes.

7.4.7 The average cost of an improved *Chulha* is Rs. 80-100. The government gives a 50% subsidy on the cost of stove to new adoptees (replacement stoves have to be paid for entirely by users). The average life of mud *Chulha*s is 2-3 years and metal *Chulha*s is 7-8 years although mud *Chulha*s can last longer if properly and regularly maintained.

7.4.8 There is considerable debate as to whether the improved stove has had much impact on fuelwood consumption. It has been estimated that 90% of the population use stoves but only 10% use improved stoves.

The main problems, identified by Dr P Saxena, of MNES, relate to:

- Communication and limited uptake.
- Coverage very small - 25% of rural/semi-urban households reached (only 25 lakhs (250,000) of stoves installed each year).
- Urban households are not included in the programme.
- Monitoring & Evaluation shows that only 17-18% of adoptees are still using improved stoves.

7.4.9 There has been a shift in emphasis of the rationale for the programme since it was established with greater emphasis now on health issues, reduction in cooking and fuel collection times. Reducing wood cutting and environmental degradation tends to be viewed more as a secondary benefit. The benefits of using improved stoves are considered as follows:

- Cleaner environment; with unimproved stoves kitchen is black with soot and very smoky.
- Less exposure to CO, TSPs, flue gases (which linger for three-and-a-half hours after cooking). Women and girls often remain in this atmosphere for considerable periods.
- Reduced cooking time - 15 -20 minutes saved per meal (2 hour cooking time)
- Less fuel - time saved enables girl children to spend more time on education.

7.4.9.1 Another important benefit for the government is the employment created by the programme. Self-employed people, mainly women, earn an income from installing stoves (Rs. 20-25 per stove x 3 fitted per day) after receiving training from the nodal agency. This strategy is in contrast to that adopted by China. Here, Rural Technology Enterprises were assigned to manufacture components where adhering to technical specifications were important to ensure improvements. The assembling was left to the household level. Employment generation was not one of the objectives of the programme (Smith: interview - December 1998.)

7.4.10 *Managing urban fuel demand:* Five sets of issues emerge which needs to be addressed and/or taken into account. These are:

I Very little attention appears to have been paid to energy needs of urban poor, either by government or the NGOs. A study carried out in the early 1990s (TERI: 1993) points out:

"One of the important critical inputs to development which has been overlooked in almost all the urban planning exercises is energy. Though some estimates talk of energy demand, nowhere is mention made of the energy demand of slum areas. These are responsible for a large share of the energy demand in these cities".

II Energy is also not an issue which many NGOs working in urban areas have addressed in the face of so many other pressing problems. Studies and needs' assessment exercises have shown that slum dwellers' priorities lie with housing, tenure, health and education, and access to water and electricity. Energy tends to have a low priority.

III The NGO, Development Alternatives was involved in a pilot dissemination programme for metal stoves. It decided to stop participating after a government subsidy to reduce the price of stoves, was withdrawn and the stove price increased dramatically, killing any village interest in it.

On the other hand, several organisations with experience of stove dissemination believe it is an error to subsidise the product because it makes people value it less, or buy it for the wrong reason or use. One observer recommended that public money be used solely for supporting the service providers, providing training etc. rather than to reduce the price of the product (G. Varughese, personal communications).

IV One NGO, CARE-India, is about to start a DFID-funded participatory development project in slum areas in Delhi. Although energy was not a topic they were going to include, the director of the programme expressed a willingness to include it in an initial needs' assessment exercise if NRI provided the main questions.

V Energy may not be the most pressing issue for poor urban households but it is obviously an area which government needs to take account of. Due to division of sectoral responsibilities between different organisations, a lack of linkages between the plan of the Delhi Energy Development Authority (DEDA) and the overall urban development planning body**-** The Delhi Development Authority, has been noted (TERI: 1993).

> "In the Master Plan for Delhi, a framework for guiding development of comprehensive urban planning for the Union Territory of Delhi, or in schemes for urban slums, no mention is made on what is being done about the energy needs of the urban poor in Delhi…
>
> If the energy demands of vast numbers of poor people in the urban areas are not taken account of in planning it is possible, even though their individual demands are low, that there will not be enough supplies to meet their needs...

7.4.10.1 The problems faced by the urban poor have not been given due attention. The energy consumption in urban poor households is between 1,256 and 2,053 kJ/capita of 'useful energy' per day. This is much lower than the minimum requirement of 2,847 kJ/capita worked out by the Advisory Board on Energy in 1985." Proper institutional linkages, a specific plan of activities and emphasis on integrated energy planning are required to solve energy problems of slum dwellers (TERI: 1993).

7.5 Findings

Based on the discussions in this chapter the following points can be made. These are:

1. **It appears that in the large cities of India the majority of urban poor have shifted to kerosene as the main cooking fuel. This is largely the impact of the high subsidy (50%) on the fuel.**

2. **Information on smaller and secondary cities is very patchy and limited. It is not clear whether this shift has also occurred in these urban areas.**

3. **The shift to kerosene has moved cooking indoors and increased environmental risks of smoke related diseases among women, children and old people.**

4. **There are many lessons to be learnt from the NPIC experience.**

5. **Limited attention has been paid to the energy needs of the urban poor. Domestic energy needs should be incorporated into integrated urban planning.**

8. IMPROVING ENERGY EFFICIENCY

8.1 Introduction

8.1.1 This chapter is devoted to examining in detail the two main management options for improving energy efficiency in households (A) Improved stoves; and (B) Fuel switching- moving up the energy ladder. These are analysed in sections 8.2 and 8.3 respectively. Each section looks at type of benefits that could be generated, various target groups and the conditions of success. They first provide an overview and then focus more specifically on India.

8.2 A: Improved Stoves in Urban Areas

8.2.1 There is a substantial history of improved stove initiatives in many countries in the developing world. Although it has not been possible to carry out a comprehensive review of programmes in different countries, it is clear that improved stove programmes have been widespread. For example, an overview of cookstove programmes in East and Central Africa (Wickramagamage: 1992) covers programmes in Botswana, Ethiopia, Kenya, Malawi, Mozambique, Rwanda, Sudan, Tanzania, Uganda, Zambia and Zimbabwe; and members of the Asia Regional Cookstove Programme (ARECOP) include Sri Lanka, Pakistan, India, Nepal, Bhutan, Bangladesh, Myanmar, Thailand, Vietnam, China, Philippines and Indonesia (Boiling Point Issue No. 33). There is already a large body of literature that has identified reasons for success and failure of stove programmes, and guidelines have been written on how to develop and manage programmes. The journal of the Intermediate Technology Development Group's Stove and Household Energy Programme, Boiling Point, is published quarterly and focuses specifically on improved stove programmes.

8.2.1.1 Given the considerable extent of existing knowledge and literature on improved stove programmes, it was decided that this section of the report would focus on the following:

- Summarising the potential benefits of improved stove programmes in urban areas;
- Identifying target groups amongst the urban poor where improved stove programmes are most likely to have positive impacts on poverty;
- Identifying key conditions for success of stove programmes; and
- Identifying limitations to stove programmes in terms of their ability to benefit poor people.

8.2.1.2 The lessons learnt from stove programmes to date are also summarised into a practical format in Appendix A *Guidelines for Designing, Developing, Monitoring and Evaluating Household Energy Interventions,* and key references on the different aspects of stove programmes are included in the Section on *Key References and Contacts* (Section 8.6).

8.2.2 <u>Benefits of Improved Stoves for the Urban Poor</u>

8.2.2.1 Experience to date shows that the *urban poor* are in general more likely to benefit from improved stoves than the rural poor, for a number of reasons:

- The urban poor are more likely to be spending money (rather than time) on acquiring fuel (see Section 6.3.2). Thus, the benefits of reduced demand for fuel, due to increased efficiency, of stoves are directly reflected in reduced financial expenditure, whereas in many rural areas fuel is still largely a “free” resource. While a reduction in labour time required to collect fuel is also a benefit, this is often outweighed by the financial cost of buying a stove.

- The urban poor are also more likely to be spending money on buying stoves, rather than constructing their own. Thus, if the cost of improved stoves are comparable to the cost of stoves currently being used, the financial cost of the improved stove is less likely to be seen as a barrier by the urban poor compared to their rural counterparts.
- The urban poor are also more likely to be using stoves of some sort in the first place, rather than an open fire. The benefits of improved stoves depend very much on the starting point, and improving on an existing stove is less likely to lead to trade-offs than the introduction of a stove in place of an open fire. As indicated below (Section 8.2.7.3), open fires often serve a wide range of functions, often including social and cultural functions, that a stove is unlikely to be able to perform.
- The urban poor are more likely to have better access to credit than their rural counterparts, so may be in a better position to spread initial capital costs of buying a new stove.
- Production, dissemination and marketing of improved stoves are likely to be easier in urban areas due to the existence of more specialised skills, greater population density, and better communications and marketing infrastructure.
- Urban dwellers may be more likely to adopt new ideas and practices than their rural counterparts.

- In India, while there has been a long history of improved stove programmes, they have largely focused on promoting stoves for use in rural rather than urban areas. Nevertheless, there may be some potential for the urban poor to benefit from improved stoves:
- 90% of the population already use stoves;
- slum areas mostly have nuclear family structures, urban poor more educated than their rural counterparts, traditional values tend to have absorbed urban/ “modern” values (R. Uma; Malini Kalianiwale, personal communications). These characteristics are likely to make urban poor more conducive to changes in practices than their rural counterparts;
- in urban areas more fuels are purchased, even dung cakes (P. Saxena, personal communication).

8.2.2.2 Opportunities may exist in small cities and peri-urban areas where wood is still the predominant fuel but is becoming scarcer and/or increasing in price. A needs’ assessment (see Appendix A) would need to be undertaken to ascertain whether the potential savings of fuelwood and/or whether there are other benefits, such as improved health, that would justify an investment programme.

8.2.3 Types of benefits

1. Reduced financial costs

8.2.3.1 If the household is buying fuel, improved efficiency of burning means that less fuel needs to be used e.g. per meal cooked, so day-to-day fuel costs can be reduced. A number of economic/financial evaluations of stove programmes indicate that such potential savings can be realised. For example, a survey of a sample of users of the two-pot Anagi stove in Sri Lanka showed that fuel savings was the main reason for urban users to buy the Anagi, and that these savings were seen as the key advantage of the stove (Watts: 1994). Appropriate Technology International (ATI) estimates that households using the Diambar stove in Senegal are saving US$103 per year on energy costs by burning less charcoal (Talking Points: 1994).

2. Reduced labour load

8.2.3.2 To the extent that urban households are collecting (rather than buying) fuel, improved efficiency may mean reduced amounts of labour spent on fuel collection. Improved stoves are also often designed to reduce cooking times, and this can be a real benefit to women. For example, responses to the survey of users of the Anagi stove (see above) in Sri Lanka showed that speed of cooking was the third most important advantage.

3. Improved health

8.2.3.3 Improved stoves can have health benefits to users from improved nutritional status, improved hygiene, and reduced risks of health problems associated with smoke pollution. A follow-up of women's groups who had installed improved cookstoves in Uganda revealed that those using the stove were able to prepare 4 meals a day due to reduced fuelwood requirements, compared to those using a three-stone fire who were only able to prepare one meal a day (Lugemwa: 1992). While links between introduction of improved stoves and health benefits are difficult to measure directly due to the influence of many external factors, some studies clearly indicate that improved stoves do lead to reduced smoke exposure. A survey in Nepal, for example, showed that improved cookstoves reduced exposure to total suspended particulates by about 67 percent and carbon monoxide concentrations by 75 percent (Karakezi *et al*: 1994).

5. Reduced risk of accidents

8.2.3.4 If an improved stove is replacing an open fire, the risk of accidents (children getting burnt, risk of setting the house on fire) can be significantly reduced.

6. Benefits to producers

8.2.3.5 The wider use of improved stoves can also have impacts on poverty through improving the incomes of poor producers, if efforts are made to train and involve small-scale producers in stove programmes. For example, both the Kenyan programme for the promotion of the Kenya Ceramic Jiko (Masakhwe: 1991) and the Anagi programme in Sri Lanka (Watts: 1994) relied substantially on small-scale traditional potters/artisans to scale up production when it became clear that there was demand for the improves stoves, and provided training and other assistance to them.

7. Indirect benefits for the rural poor

8.2.3.6 While consumption of fuelwood and charcoal by urban households is by no means the only cause of depletion in wood resources, it can have a very substantial impact on rural areas surrounding cities and towns. Urban demand for fuelwood and charcoal can have negative impact on poor rural households in the surrounding areas, both in terms of direct competition for fuel resources where these are scarce, and in terms of commercialisation of the resources, which often leads to rural households having to pay for their fuel where in the past they were able to collect fuel for free. If adopted by a substantial proportion of urban households, improved efficiency stoves can therefore benefit poor rural households living in surrounding areas.

8.2.4 The Indian experience

8.2.4.1 Conflicting views on the success of the improved *Chulha* programme are apparent, depending on whether one talks to the staff of the ministry concerned (MNES), the NGO which implements part of the improved stove programme or the research institute which has evaluated it, although all agree that improvements could be made and that the programme could be more successful if particular issues were addressed. These are discussed in more detail below.

8.2.4.2 As has been shown elsewhere the issue of introducing improved stoves is quite complex. Designing an improved biomass stove is relatively straightforward from an engineering perspective but ensuring its sustainable uptake is much more difficult, with numerous angles of financing, training, awareness raising and targeting to consider. Traditionally women are used to making their own stoves, from three stones and some mud and dung, which involves little or no investment. To divert scarce household resources into an improved *Chulha* may not seem advantageous if fuel is still relatively abundant, and better cooking conditions may not seem very important to the male head of household.

8.2.4.3 Benefits, achievements and limitations of India's initiatives

Benefits

- Uptake – the number of improved *Chulha*s increased from 0.8m in 1985 to over 12m by 1992. Some 2m stoves are installed every year but annual mortality is high (estimated at 20%) and there is, thus, little increase in stock.

- Reduced fuel consumption – under laboratory conditions improved *Chulha*s use 1/3 of the fuel required to cook the same quantity of food on a traditional stove. Under household conditions there is a wide variation in efficiency as stove performance is very sensitive to design parameters and it is estimated that overall there is only a 40% gain in efficiency (Natarajan: 1995). Energy efficiency not a major issue for poor people - food, health, water, employment, education etc. more important than fuel. However, the All India Women's' Conference (AIWC) has found considerable fuel saving can be realised with proper installation and maintenance. With improved *Chulha* 15 minutes' cooking time can be saved each meal (2 hours' cooking time).

- Reduced exposure to pollutants – following an evaluation of the NPIC, it was suggested to the MNES that they stress that the improved stoves are smoke free rather than fuel saving (Natarajan, *op.cit*.). Better combustion plus the use of a chimney significantly reduces smoke emissions.

- Cleaner indoor environment – Women perceive of smoke as a health problem. A benefit of improved stove includes healthier eyes. They also note of savings of money/time and less drudgery in collecting sufficient wood. However, men are not directly affected by stoves and cooking fuel and often fail realise it is a problem for women and children. Better combustion also means less time cleaning sooty utensils.

- Cost/subsidy – There is considerable discussion over whether improved stoves should be subsidised. Mrs Balakrishnan of the AIWC felt strongly that *Chulha* subsidy programme should continue, particularly when electricity, kerosene and LPG are subsidised although she believed that women should pay something towards stove (L. Balakrishnan, personal communication). The evaluation of the NPIC considered, however, that due to the limited stake that each household had in the stove they did not value it (the total cost of an improved *Chulha* is Rs. 90-125, of which the government contributes Rs. 40) or opted for the *Chulha* only because it gave them access to subsidised components which were often found to be used for other purposes e.g. chimney pipes (the most expensive part being a 3" diameter cement sanitary pipe) used in a latrine, in irrigation channels or sold (Natarajan, 1995).

- Installation - Selected women in the chosen village are trained in *Chulha* construction. These trainers/stove builders are self-employed workers (SEW) who receive a 10-day training course from a master craftsman. The SEW learn the vital measurements by using hand spans (The AIWC teach the SEW songs in which the measurements are included in the words to help the women remember them. The AIWC has trained more than 3,000 women). Each SEW receives Rs. 30 for each stove constructed (Rs. 15 after stove construction and Rs. 15 after 6 months to a year). She is supposed to provide support and assistance for one year. If a pottery liner is used three stoves can be built in a day. However, stoves are often badly constructed with the SEW little idea about how it should be done. The training element needs more emphasis and opportunities for commercialisation should be explored. A simplified construction method - using one mould – would also help.

- Maintenance – the *Chulha* needs regular maintenance to keep it functioning properly; the channel subsides and needs to be rebound with mud, and the chimney cleaned every 2-3 weeks. Regular cleaning extends the life of the chimney. Cleaning the chimney is supposed to be a man's job but not many people like to do it.

- Education/awareness raising – stove programmes are supposed to include training for the users but the quality and content of the training programmes is often poor and many issues may not be explained. For example, women think they should be able to see flame around the pot when cooking to know stove is working; they think the stove isn't working efficiently if there's no flame. However, for improved *Chulha* to work efficiently there should be no gap between vessel and *Chulha*. It is also alleged that many people are unaware of the benefits of *Chulha*s.

  > "In some cases, the decision makers being men, do not appreciate the benefits of improved *Chulha*s, because, they have never experienced any problems with the existing *Chulha*s, for the simple reason that they have never cooked or worked in the kitchen!" (Kumar, 1995, pp. 13).

Achievements

- Design/suitability of model – some 65 improved *Chulha* models have been developed including a stove for reducing milk. The AIWC programme assists women select most appropriate model. They give a demonstration, and ask about types of food cooked and how frequently; whether they cook outside or in and the types of fuel used before suggesting which model(s) may be appropriate.

However, it has been suggested (Kumar, *op.cit*.) that there is a lack of different types and sizes of *Chulha* to suit different economic groups.

> "The present model is too expensive for the poor, but is too inelegant, though inexpensive, to find a place in the beautiful kitchen of those who are better off. The model is too big for a small family, but too small for a large one… we should try to develop and propagate different sizes and types of *Chulha*s to suit different sizes of families and for different economic strata of the society. Monolithic models which require little skill in installation, and cast iron and stainless steel-clad fixed *Chulha*s which rhyme with the décor of the modern kitchen need to be developed."

Limitations

- Target fulfilment – the way in which the NPIC operates contributes to its problems. Firstly, the MNES has an annual national dissemination target. This is broken down into state, district and village quotas. Village development workers have many targets from many development programmes of various departments. They may not consider the *Chulha* is a good project or may concentrate on other programmes. Two months before end of year he gets a reminder of *Chulha* target and has to rush around ensuring quota is met. He will not necessarily target stoves to poorest, just to whoever will take one. However, in spite of the limitations of a number-based target the government thinks that without targets nothing will get done. Secondly, in some cases the government target is quickly exhausted and no funds are left to provide *Chulha*s to additional people who may wish to have one. Because the main *Chulha* components are bulk purchased they are cheap. It is expensive to purchase individual components such as chimneys or they may not be available which discourages Self Employed Women from disseminating their own stoves.

- In certain improved models it is crucial that technical specifications are adhered to. Artisan-based production often makes that difficult.

Way forward

- Most people interviewed felt that the improved *Chulha* programme should be continued but with improvements. Lessons learned should be incorporated. The dissemination steps are known (needs identification, technology specification, pilot marketing); a process that takes 7-8 years. More use could be made of NGOs and other genuinely interested organisations rather than relying on target-driven government departments. Women should be more involved in design, dissemination and uptake. People do buy things if they want them. Demonstration is important. Ten to 15 villages could be adopted in each state and demonstration stoves installed in each. If people see they work they will want one. Previously, assistance programmes from various ministries tended to operate in parallel. Now more effort is made to liase between programmes. Greater targeting is necessary e.g. target women with small fuel-using businesses such as snack producers. An *idli*[1] maker who had an improved *Chulha* installed through the AIWC found that she gained considerable benefits from it. She saved money on fuel; per utensils needed less cleaning as soot doesn't form and her profit margin improved. A secondary benefit was that her children didn't get sick from smoke-related diseases.

[1] *Idli* is a rice-based snack.

8.2.5 Target groups

8.2.5.1 The purpose of this section is to highlight those groups who are most likely to benefit from improved stoves. This does not imply that other groups should not be targeted. However, experience has indicated that stove programmes are more likely to succeed if they start off with well-targeted groups where success is most likely, even if they eventually move on to a wider range of groups.

8.2.5.2 In the context of the focus of this study (i.e. the urban poor), experience has shown that the following groups are most likely to benefit:

- Poor urban households who are already using and buying stoves.
- Poor urban households who are spending a large proportion of their incomes on fuel.
- Poor urban households who usually cook indoors (pollution caused by stoves is much less of a problem for users if cooking outside);
- Where alternative fuel sources are not viable options: e.g.
    - the fuel itself is too expensive
    - the fuel is difficult to get hold of (e.g. only sold in bulk, or only through formal outlets)
    - alternatives sources are unreliable e.g. electricity, mains gas
    - appliances required to use alternative sources of energy (e.g. kerosene stoves or lanterns, coal burners, solar cookers) are too expensive and/or are difficult to get hold of.
- Where cooking is the most important function of the stove/fire, and other functions are considered much less important.
- Groups who themselves identify aspects of stove use as a key problem(s) e.g. complaints about smoke, high prices of fuel.
- Where there are institutions and mechanisms already in place to scale up the stove programme, including existence of producers (e.g. existence of a traditional stove industry, or potters with relevant skills), distribution outlets, NGOs interested and able to assist in promotion and training.

8.2.5.3 Proposed target groups in India might include:

- Urban areas where there is more reliance on biomass fuels (not in the mega cities: Delhi, Calcutta, Bombay and Madras), e.g. smaller towns/cities, outskirts of larger cities (dung cakes);
- Climatic areas where there is longer monsoon season and colder weather (people more likely to cook inside when it is cold and/or raining) i.e. where indoor air pollution is more likely to be a problem;[but need too consider space heating requirement in colder areas – improved stoves are too efficient.
- NGOs might focus on slum areas where there are poorer facilities (e.g. subsidised kerosene/ration cards, electricity connection) but this may be controversial - these areas have poorer facilities because the government doesn’t want them to exist (M. Kalianiwale, personal communication).

8.2.6 Conditions for success

8.2.6.1 While different situations demand different conditions, the following are some general lessons learnt from stove programmes to date:

- Potential users of improved stoves need to be integrally involved in identification of problems to be addressed, evaluation of options, and design, testing and evaluating of stoves;
- Considerable investments need to be made in the appraisal and design stage, and in developing a long term stove production, maintenance and marketing strategy;
- Provision of credit to those interested in buying the stoves, so that they can spread the initial investment cost over a period of time;
- Adequate provision for training, both in terms of training users in the benefits, use and maintenance of improved stoves, and in terms of training people involved in the production and repair of the stoves.
- Adaptability of stoves. Many poor households use a range of fuels for a range of purposes. In order to be acceptable to users, new stove designs need to be flexible in this way;
- Recognition that a stove that is successful in one place and with particular groups of people may not be successful elsewhere.
- Understanding the range of stakeholders, their interests in stoves, and the constraints they face. These include potential users, traditional makers of stoves or similar artisans e.g. potters, existing retailers of stoves in both the formal and informal sector, government departments involved in household energy programmes, and NGOs and community groups working with poor urban households.
- Based on such an understanding, successful stove programmes have tended to build on existing institutions, skills and structures, exploiting existing capabilities of different groups.

8.2.7 Limitations of improved stoves for the urban poor

8.2.7.1 Many stove programmes have been heavily criticised in the past. This has been partly the result of over-ambitious goals (see Sections 8.2.7.5 and 8.2.7.6, below), and many of the criticisms and problems apply much more to rural areas than they do to urban areas, where many of the constraints are not significant. Moreover, many lessons have already been learnt from mistakes of earlier programmes. However, given that there are other options for addressing the problems associated with fuel scarcity and smoke pollution (see Section 6.3.2), it is important to recognise the limitations of improved stoves for poor urban households.

1. Financial costs.

8.2.7.2 Use of a new stove may incur additional investment (capital) costs, since it may be more expensive than currently used stoves, and would certainly cost more than an open fire. This initial capital outlay required can be a serious constraint to purchasing an improved stove for poor households, even though this constraint is reduced if people are already using commercial stoves (which is the case for a substantial proportion of urban households in India), and/or if measures are taken to spread the initial cost through credit or similar arrangements.

2. Loss of or reduced benefits from other functions of the traditional stove or fire.

8.2.7.3 Improving stove efficiency generally involves constraining the flame to intensify the heat output so as to increase cooking efficiency. However, this involves trade-offs with other functions that the traditional stove or fire performs. Again, for those households who are already using some form of stove, the range of functions, and therefore potential trade-offs, are likely to be less. For those using an open fire, the trade-offs are likely to be high. As indicated in the table below, the open fire can have a wide range of functions.

Multiple functions of open fires:

- **Flame** ➪ lighting
  - ➪ ritual significance
  - ➪ entertainment
- **Heat** ➪ cooking
  - ➪ space heating
  - ➪ drying food, fuel and house materials
  - ➪ control of pests in thatched roof
- **Smoke** ➪ preserving and flavouring food
  - ➪ control of mosquitoes and other insect pests of humans and livestock
  - ➪ preservation of house structure (wood, thatch)

(Adapted from Smith: 1989)

8.2.7.4 Improved efficiency in the cooking function can therefore lead to interference with the performance of other functions. e.g.

- ♦ smoke removal may reduce risk of eye and respiratory diseases, but may increase risk of mosquito borne diseases such as a malaria in areas where such diseases are important.;
- ♦ by increasing a stove's cooking efficiency, its space heating and lighting functions are likely to be reduced.

8.2.7.5 Because of the range of potential benefits, improved stoves were popular as a single technology to solve multiple problems. However, there appears to have been a tendency to impute indirect gains from certain direct impacts, based on assumptions that are not always true.

8.2.7.6 For example, stove programmes in the 1970s often included as a key aim the reduction of deforestation, in order to preserve the fuelwood resource for the future. The assumption was that increased population growth and economic development led to increased domestic fuelwood consumption, which in turn led to increasing rates of deforestation. Introduction of energy efficient stoves were thus seen as a solution to this "energy crisis", by decreasing rates of deforestation. However, the initial assumption was flawed in that there are often much more important contributors to deforestation, e.g. land clearance for agriculture, ranching, or commercial logging.

8.2.7.7 Another claimed benefit of improved stoves is the "emancipation of women", which is supposed to occur by freeing up women's time from collecting fuel and cooking, and therefore allowing them to engage in more productive and investment activities which would give them a chance for a better life. Similarly, improvements in women's health as a result of reduced risks from smoke pollutants are seen to improve women's chances in engaging in "emancipatory" activities. In practice, however, such benefits are unlikely to occur unless other factors are put into place to make them happen. In a society such as India, for example, there are a number of cultural values that would discourage many women from pursuing further education, setting up a new economic enterprise, etc., that are likely to limit opportunities for women to use their spare time to carry out such “emancipatory” activities.

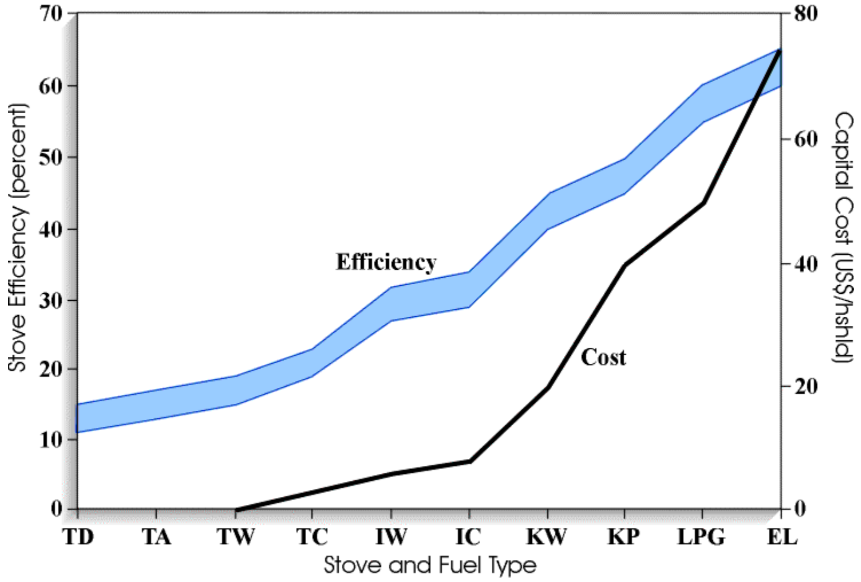
8.2.7.8 Key limitations of improved stoves for the urban poor in India:

- In Delhi, Calcutta, Bombay and Madras many poor urban households are using kerosene rather than biomass fuels because the former is cheaper. Kerosene is already a pretty efficient fuel (higher up the “energy ladder”), and there is little room for improving energy efficiency of kerosene stove models currently being used. The number of households that could benefit from improved biomass (especially wood) stoves therefore likely to be limited in the largest cities.
- A large number of households who do use biomass stoves cook outside for a significant proportion of the year. Therefore, while improved efficiency stoves may have benefits in terms of savings in fuel costs, direct benefits to the users from reduced pollution are likely to be small.
- The urban poor prioritise many other needs or development objectives over and above improvements in energy for cooking and heating, e.g. urban poor prioritise connections to water supply and electricity (for lighting, television etc.) (interview with Malini Kalianiwale, 14.12.98; field visits), food, employment, education, access to health facilities (interview with Natarajan, 15.12.98).
- Even for those households who do currently use biomass fuels, they may be unwilling to invest in an improved biomass stove due to quite frequent changes in the relative costs of alternatives fuels over the last couple of decades (partly due to government policies), and therefore uncertainty over what will be the cheapest fuel in the future. One study showed that 56% of wood users also own a kerosene stove, and 44% of kerosene users also own a wood-burning stove (Saksena *et al.*, in Biomass Energy Systems).

8.3 B: Fuel Switching – Moving Up the Energy Ladder?

8.3.1 The option of switching to more efficient fuels – moving up the “energy ladder” – should be considered as a complementary strategy to improving stoves. As explained above (Section 6.2.1.2 to .5), there are however a number of constraints that the poor face in accessing these more efficient fuels. In many developing countries, these constraints are probably difficult to remove in the short-term, but should be considered as part of a longer-term strategy for domestic energy policy. Nevertheless, Munslow *et al* (1998) suggest that the key constraints to access for the poor are unreliability of supply, and high initial capital costs of acquiring appliances for using new energy sources. There are likely to be ways of tackling both these constraints in the short term if policies and programmes prioritised the interests of the poor.

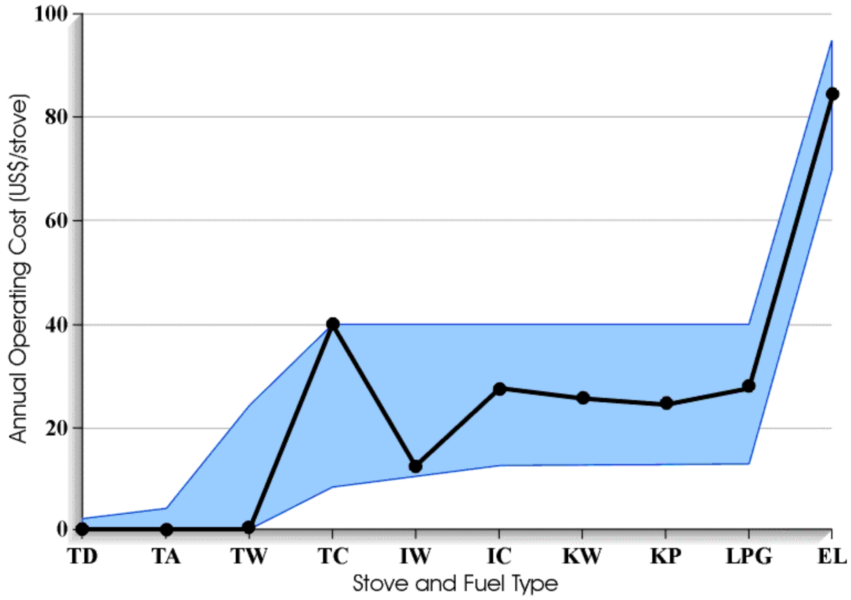
8.3.2 The urban poor are often characterised by relying on a range of fuels for any given function. Where sources of fuels such as electricity, coal or LPG are erratic, the urban poor may rely on fuelwood or charcoal as a fall-back energy source. This suggests that strategies to encourage fuel-switching would better suit the needs of the poor if they aimed to maximise fuel options available to the poor, providing them with a choice, rather than encouragement of more efficient fuels at the expense of more traditional fuels.



Stoves listed are: (TD), (TA), (TW), (TC)—traditional stoves using dried animal dung, agricultural residues, wood, and charcoal, respectively; (IW), (IC)—improved wood and charcoal stoves; (KW), (KP)—kerosene wick and kerosene pressure stoves; (LPG)—LPG or natural gas stoves; and (EL)—electric resistance stove. Efficiencies and capital costs are for the stove alone and do not include up-stream capital costs for producing and delivering fuel. The range of performance both in the laboratory and in the field is much larger than that suggested by this figure and is affected by such factors as the size of the stove and pot, the climate (wind), the quality of the fuel used, the care with which the stove is operated, the type of cooking done, and many other factors. The type of material that the pot is made of is also a significant factor.

Figure 8.1. Representative Efficiencies and Capital Costs for Various Stoves

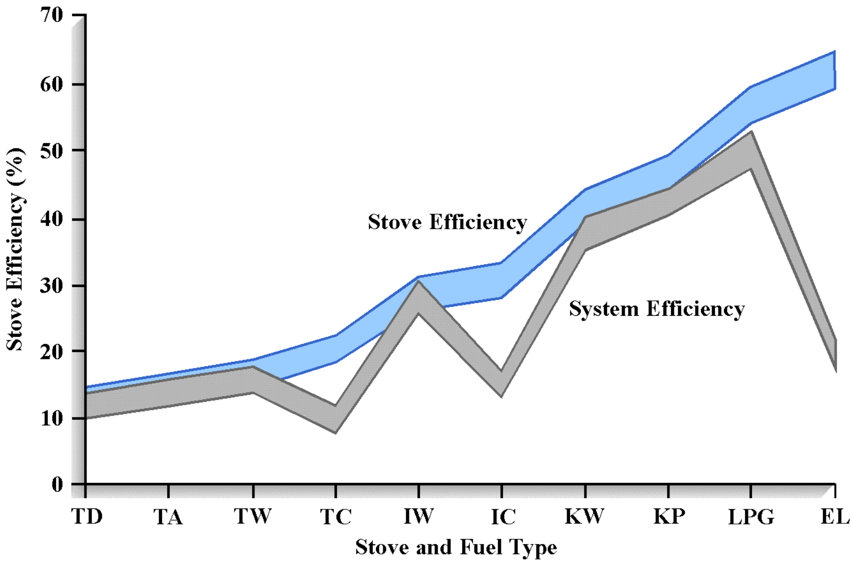
Source: Energy After Rio: Prospects and Challenges, UNDP (1995)



Data points show the cost as estimated from the nominal values. The blue-band suggests the wide variation in costs using any particular stove depending on local stove and fuel costs, diet, and a host of other factors.

Figure 8.2. Annual Cost of Cooking for Different Stoves

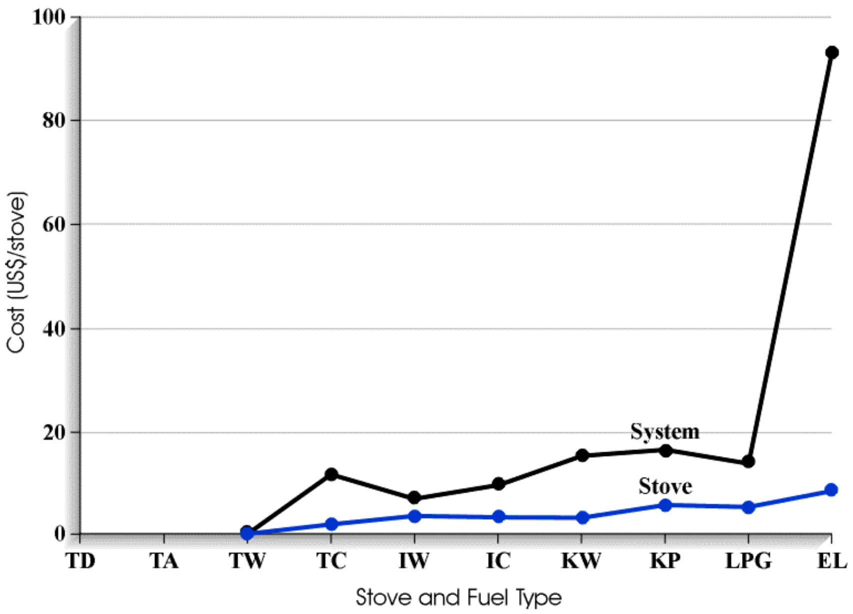
Source: Energy After Rio: Prospects and Challenges, UNDP (1995)



Stove efficiencies are nominal values for the stove alone; system efficiencies include the energy loss in producing, converting, and delivering fuel to the consumer. (See caption for Figure 8.1 for the identification of alternative stoves). Note, particularly low system efficiencies for charcoal (TC and IC) and electric (EL) stoves due to the large energy losses in converting wood to charcoal, and fuel to electricity. Source: (OTA, 1992b).

Figure 8.3. Stove and System Efficiencies

Source: Energy After Rio: Prospects and Challenges, UNDP (1995)



When system costs are included, electric stoves can be seen to be particularly expensive. There is a wide range of costs around these nominal values. See the caption for Figure 8.1 for identification of alternative stoves.

Figure 8.4. Stove and System Capital Costs

Source: Energy After Rio: Prospects and Challenges, UNDP (1995)

8.3.3 When considering the wider environmental benefits, system efficiencies and costs are important. This is shown in Figures 8.3 and 8.4. System efficiencies include stove efficiencies and efficiencies of producing energy carriers (e.g. efficiency of production, transport and transmission of charcoal, electricity, and petroleum products). System costs include upstream costs for producing energy carriers (charcoal, electricity, LPG etc.).

8.3.4 Moving up the energy ladder in India: the case of kerosene

8.3.4.1 Government policies over the last couple of decades have had a substantial influence on patterns of energy consumption amongst the urban poor in India. Experiences with subsidisation of coal and kerosene supplies for the urban poor have some important lessons for consideration of fuel-switching policies in other countries. While other factors such as changes in availability of fuelwood and costs of mining/distributing coal have undoubtedly had a major influence, subsidisation of kerosene have led to changes in their cost relative to alternative fuels and this in turn has encouraged the urban poor in some major cities to switch from biomass fuels to coal and, more recently, kerosene. Common constraints to fuel-switching (see Section 6.2.1.5) appear not to have been a problem: the cost of coal and kerosene-burning stoves appears not to have restricted poor households from using either of these fuels. A kerosene stove can be purchased from around Rs. 80 (around £1.20) and kerosene is relatively flexible in that it can be used both for cooking and lighting. LPG stoves cost between Rs. 200 and Rs. 2,000 (£3 to £29).

Table 8.1 Cooking Energy Consumption Patterns in Two Delhi Slums

Fuel category	**Slum location (air quality)**	**Number of meals cooked per day**	**Daily time spent cooking (hours)**	**Burn rate (kg/hours)**	**Fuel use (kg/capita/ day)**	**Useful energy consumption (kcal/capita/ day)**
Wood	High	1.4	1.70	1.42	0.40	222
	Low	2.0	2.20	1.33	0.60	336
Kerosene	High	1.9	2.20	0.16	0.06	263
	Low	2.4	2.10	0.16	0.08	321

Source: Saxena *et al*: 1996.

8.3.4.2 In particular, the recent shift towards kerosene usage, which includes a large proportion of the urban poor in Delhi and Calcutta, is at one level an impressive achievement in that the shift from biomass fuels to kerosene involves a substantial move up the “energy ladder” i.e. much higher stove and system efficiencies (see Figure 8.2). The higher efficiency of kerosene as a fuel, other things being equal, entails lower per unit energy costs and reduced outside pollution levels.

8.3.4.3 However, the experience in India indicates that in practice there have been significant costs involved for urban households who have switched from biomass fuels to kerosene. In a study by TERI and medical researchers (Sharma *et al:* 1998) which compared wood and kerosene users in two large slums in Delhi, it was shown that the incidence of respiratory diseases in infants was in fact slightly higher in kerosene users. This was due to two factors:

1. Kerosene stoves are much more likely to be used indoors than outdoors compared to wood stoves (only 32.5% of wood users cooked indoors compared to 69.1 % of kerosene users). This is because whereas a breeze helps to keep a wood stove/fire alight, the pressurised jet system characteristic of many of the kerosene stoves used cannot cope with a breeze. Also, young children of kerosene users are kept indoors where they can be kept an eye on while children of wood users could either be outside with their mother or be put inside. Therefore, even if the actual emissions from wood stoves are more toxic, levels of exposure and health risk to users (women and children) can be less than for kerosene users because the environment (outdoors) is much better ventilated, and women and children are likely to spend less time near the stove if it is outside.

2. With current subsidies, the switch to kerosene from fuelwood may have involved a reduction in fuel costs for users, and therefore an increase in purchasing power. The study suggests that this increase in purchasing power has allowed households to cook more meals per day because of lower per unit energy costs and/or increased expenditure on food. While a greater number of cooked meals has potential benefits in terms of improved nutritional status of the household, it also means exposure for longer periods of time for women and infants to pollutants from the stove, and therefore potential increase in incidence of respiratory, eye diseases etc. Table 8.1 shows that per capita useful energy consumption was higher in the kerosene-using households.

8.4 The Roles of Different Institutions

8.4.1 Due to time constraints, it has not been possible to carry out a comprehensive review of the advantages and disadvantages of involving different types of institutions in different stove programmes. Moreover, while some generalisations can probably be made in terms of the comparative advantages of certain types of institutions e.g. NGOs in performing specific roles such as provision of training on stove production and use, enormous differences in the institutional context between different countries questions the usefulness of trying to draw too many generic conclusions. Different countries have different types of institutions, and the same types of institutions may play quite different roles e.g. governments may have very different priorities, and there is a lot of variation between countries in terms of the areas of activity, capacity and independence of the NGO sector.

8.4.2 Nevertheless, one key lesson from experience to date has been that those programmes which have been successful tend to have been effective at linking in to a wide range of existing institutions at different points in the programme “chain”, building on mechanisms and capabilities that already exist. This suggests the importance of developing a good knowledge of the range of potential stakeholders/institutions and their activities, understanding their opportunities and constraints, and developing partnerships with appropriate stakeholders based on this understanding.

8.4.3 In order to assist in the process of identifying potential stakeholders, the research team has attempted to summarise the range of institutions that have been involved in the different stages of stove programmes (see Box 8.1 below). This table has been compiled based on reviews of a wide range of stove programmes in different developing countries that have been published in past issues of *Boiling Point.*

Box: 8.1 Summarising the Range of Institutions that have been Involved in Different Stages of Stove Programmes

R&D:	Donors (e.g. ESMAP/WB in Ghana) Implementing agencies (government department, NGO) Local research institutions (e.g. UST, Kumasi involved in lab testing of prototypes) Market researchers/consultants
Production:	Local potters (e.g. KCJ) Women's groups (e.g. Kenya rural stove programme) Large commercial manufacturing companies (e.g. Alfa producing Ahibenso, Ghana) Rural Energy Companies, China Selected local individuals who receive training (e.g. ApTT in Karnataka)
Promotion:	NGOs (e.g. KCJ – KENGO etc.) Government extension networks (e.g. Home Economics Officers (HEOs in Kenya) Media/publicity consultants (e.g. Ghana coalpot) Different promotion methods involving different institutions, e.g. radio, TV, newspapers, public transport systems, schools, demonstrations in fairs (Melas in India) etc. Community groups e.g. women's groups
Distribution:	Government extension networks (e.g. Home Economics Officers in Kenya) Commercial retail outlets - small shops / supermarkets / market places (e.g. KCJ) Sold directly by artisans / producers (e.g. KCJ) NGOs (e.g. Development Alternatives, India) Traditional community structures (e.g. village councils, ApTT project in India)
Training:	Government services (e.g. HEOs in Kenya, Technical Back-up Service Units in India) NGOs (e.g. KENGO in Kenya) Trained local individuals - training on stove construction, installation, maintenance (e.g. ApTT project, India)
After-sales service:	NGOs (e.g. Development Alternatives, India) Commercial producers
M&E:	Women's groups (e.g. Ghana coalpot) Local research institutions (e.g. National Council of Applied Economic Research, India) Donors
Funding:	International donors (e.g. WB, GTZ, ITDG) NGOs Commercialisation of production and distribution – profit-making / self-sustaining National governments (China, India)
Quality control:	China- Rural Technical Enterprises. India -Technical Backup units.

8.4.4 One of the key current debates in stove programmes is about the advantages and disadvantages of commercialisation of different aspects of the programmes. Key points that have emerged from a review of *Boiling Point* articles are summarised in Box 8.2 below.

Box: 8.2 Issues Regarding Commercialisation of Stove Programmes

- **Factors conducive to commercialisation / semi-commercialisation / public sector management**

  Stove programmes in urban areas likely to be more conducive to commercialisation than rural areas

  Small, portable stoves more conducive to commercialisation than larger "built-in" stoves

  Well-developed and sophisticated local potter/artisan sector conducive to effective commercialisation of production

  Relative benefits of commercialisation of distribution may depend on strength of local government and NGO institutions / networks

- **Aspects / components of stove programme conducive to commercialisation**

  Production, distribution; possibly promotion, training and after-sales service

- **What types of commercial institutions should be involved?**

  Producers:

  Those who are willing to take risks and initiatives, as well as simply meeting orders

  Those with existing skills that can be easily adapted to make improved stoves / parts

  Formal vs. informal sector producers: it may be easier to control quality in formal sector, but encouragement of informal sector production can mean direct benefits to small-scale artisans (greater poverty impact?).

  Distribution:

  Retailers / outlets that are frequented by the urban poor should be targeted, e.g. market stalls selling kitchenware.

- **What support needs to be provided to commercial institutions?**

  Training on stove construction and maintenance (producers), and proper use and benefits (distributors).

  Quality control.

- **Implications of commercialisation for targeting the urban poor**

  There are concerns that commercialisation makes it more difficult to reach the poor due to higher prices (no subsidies) and private sellers not reaching the poor. However, in practice many stove programme. using non-commercial distribution systems e.g. govt. extension networks also tend not to reach the poor. Also, it may be possible to specifically target those informal outlets/sellers which the poor do frequent.

- **Funding implications of commercialisation**

  The advantage of commercialisation is often seen as distributing more stoves for less money from funding agencies, and greater sustainability after end of project. However, in practice, while commercialisation may lead to reduced need for donor support in the long run, in order to make it work there are considerable donor investments that need to be made initially (e.g. market research, advertising, production set-up). Moreover, there are certain aspects of stove programmes that are difficult to commercialise and might need to be covered in the long term by non-commercial bodies e.g. training, M&E, quality control.

8.4.5 Institutions involved in stove programmes in India

8.4.5.1 The principle organisation involved in the National Programme for Improved *Chulha*s (NPIC) is the Ministry for Non-Conventional Energy Sources (MNES). It forms part of the government's twenty point and minimum needs programme. The MNES allocates funds to state governments and is responsible for R&D, carried out by 17 technical back-up units. The NIPC is implemented through state nodal departments and nodal agencies: autonomous bodies, housing corporations, government departments, programmes, state agro industries corporations and one NGO, the All India Women's Conference to meet an annual distribution target. The state implementing agencies provide support at the district, block and village levels.

8.5 Conclusions and Findings

1. **Energy is an issue, though not a priority, for poor people in urban areas. Most of the fuel used is purchased and because people have to purchase in small quantities or cannot afford the large deposit required for a gas cylinder they may pay more per unit of energy consumed than much richer families and use a larger proportion of their, limited, income on fuel.**

2. **However, it became apparent during the field visit to India that there may be limited opportunities for improving efficiency of energy use, other than assisting households to move up the energy ladder, in the big cities. In towns, small cities and peri-urban areas there may be more interest in investing in an improved wood-burning *Chulha*, though possibly from an improved health perspective than from potential energy savings.**

3. **Woodfuel users are the poorest in urban areas often transient/new arrivals. Additionally, they cook outdoors. They are difficult to target. Many will probably eventually switch to kerosene (due to opportunity cost of woodfuel collection; peer pressure, safety aspects). This implies a need to examine opportunity for supporting improved *Chulha* programme in appropriate areas.**

4. **Kerosene users need to be targeted through health programmes and to increase their awareness of dangers of using kerosene in a poorly ventilated rooms.**

5. **There is need to put energy on the urban planning agenda. At present it has no place in urban management in India.**

8.6 A Guide to Key References and Contacts

6.1 Introduction

Nelson V. (1996) *Rural Energy Security: A Literature Review.* A report for the DFID Forestry Research Programme, Fuel-efficient technology: Incentives and Constraints to Household Adoption Project. Natural Resources Institute.

6.2 The Problems: Links between Energy and Poverty at the Household Level

Reddy A.K.N., Williams R.H. and Johansson T.B. (Year?) *Energy After Rio: Prospects and Challenges.* UNDP in collaboration with International Energy Initiative and Energy 21, Stockholm Environment Institute.

Section 2.1: Energy and Social Issues.

6..2.1 The urban poor and household energy use: setting the scene

Gopalan S. (1990) *Energy for Cooking and the Poor.* In: Journal of Rural Development, Vol. 9 (1), pp. 153-172. (This article provides a general overview of factors that lead the poor bear the brunt of increasing prices of biomass fuels, and restrict their opportunities to shift to more energy efficient fuels. It has a special focus on India).

6.3 The conceptual framework

6.3.2 Poverty impacts of fuel scarcity

ITDG (1992) *Women, Woodfuel, Work & Welfare*. Boiling Point, ITDG, Rugby, UK. No. 27, April 1992

6.3.2.4 Health costs

ITDG (1992) *Women, Woodfuel, Work & Welfare*. Boiling Point, ITDG, Rugby, UK. No. 27, April 1992

Fuel Shortages and Women's Health (pp. 2-4)

6.3.3 Health problems associated with inefficient combustion of fuels

ITDG (1994) *Smoke Removal*. Boiling Point, ITDG, Rugby, UK. No. 34, September 1994.

Introduction (pp. 1-2)

Smoke in the Kitchen (pp. 3-4)

Smith, K. (1991) Biomass cookstoves in global perspective: energy, health, and global warming, Paper prepared for the Informal consultation of epidemological, social, and technical aspects of indoor pollution from biomass fuel, WHO, Geneva

6.4 Options for Addressing the Poverty Impacts of Fuel Scarcity and Inefficient Combustion

6.4.1 Options for Addressing Fuel Scarcity

Munslow B., Katerere Y., Ferf A. & O'Keefe P. (1988) *Part Three: Urban Areas.* In: The Fuelwood Trap: A Study of the SADCC Region. Earthscan Publications Limited, London, UK.

11.4.1.4 Changes in Household Practices

Nelson V. (1996) *Rural Energy Security: A Literature Review.* A report for the DFID Forestry Research Programme, Fuel-efficient technology: Incentives and Constraints to Household Adoption Project. Natural Resources Institute.

Chapter 4: Household coping strategies for fuelwood scarcity (pp. 18-23)

6.4.2.5 Options for addressing the health impacts of pollution due to Inefficient combustion

6.4.4 Conclusions

8.2 Improving Energy Efficiency (A): Improved Stoves in Urban Areas

Boiling Point: Stoves and Household Energy Programme, Intermediate Technology Development Group. This is a quarterly journal which focuses specifically on improved stove programmes in developing countries, with a practical and interdisciplinary perspective.

Household Energy Developments in Asia. Boiling Point, Issue No. 34, May 1994

Household Energy Developments in Southern and East Africa. Boiling Point, Issue No. 29, Dec. 1992

Asia Regional Cookstove Programme (ARECOP): Jalan Kaliurang KM 7, PO Box `9 Bulaksumur, Yogyakarata, INDONESIA. This is a network whose aims are to increase communication, exchange of expertise and provide support to local stove initiatives in countries in the Asia region.

KENGO. P.O. Box 48197, Nairobi, KENYA. This is an NGO who was centrally involved in the Kenya stove programme which included the Kenya Ceramic Jiko, and is now recognised as a regional centre of expertise on stove programmes.

Energy Sector Management Assistance Programme (ESMAP), UNDP/World Bank. ESMAP aims to provide technical assistance and institutional support to energy sector institutions in developing countries. Nearly 50% of ESMAP's resources have been used to fund household energy initiatives.

8.2.1 Introduction

8.2.2 Benefits of Improved Stoves for the Urban Poor

8.2.4 Types of benefits to the poor

8.2.6 Target groups

8.2.7 Conditions for success

8.2.8 Limitations of improved stoves for the urban poor

8.3 Improving Energy Efficiency (B): Fuel-switching – Moving up the Energy Ladder?

8.4 The Roles of Different Institutions

Appendix A: Preliminary Guidelines for Designing, Developing, Monitoring and Evaluating Household Energy Interventions

German Appropriate Technology Exchange (1980) *Helping People in Poor Countries Develop Fuel-Saving Cookstoves.* Produced by Aprovecho, Eugene, Oregon, U.S.A. (This is a manual on how to develop improved stove programmes, with a good overview of the various stages involved from appraisal to promotion and dissemination. It provides a good balance between social and management issues on the one hand, and practical and technical issues on the other hand.)

1 Identify the Problems

2 Identify potential solutions

3 Hold consultations with target groups (poor urban households) to refine definition of problems

3.4 Develop an understanding of *social issues* that influence or are influenced by stove use

German Appropriate Technology Exchange (1980) *Helping People in Poor Countries Develop Fuel-Saving Cookstoves.* Produced by Aprovecho, Eugene, Oregon, U.S.A.

Chapter II: Finding Information: Socio-cultural Checklist (pp. 31-2)

3.4 Develop an understanding of *technical issues* relating to stove use

German Appropriate Technology Exchange (1980) *Helping People in Poor Countries Develop Fuel-Saving Cookstoves.* Produced by Aprovecho, Eugene, Oregon, U.S.A.

Chapter II: Finding Information: Technical Checklist (pp. 33-4)

4 Design and field test a range of prototype stoves in collaboration with target groups

German Appropriate Technology Exchange (1980) *Helping People in Poor Countries Develop Fuel-Saving Cookstoves.* Produced by Aprovecho, Eugene, Oregon, U.S.A.

Chapter III: Developing Stoves with Local People: the role of the development worker

5 Evaluate prototypes, and draw up profiles for most successful prototypes (advantages, disadvantages, who it is most likely to benefit, under what conditions, constraints to adoption)

6 Identify methods for promotion, dissemination, production, marketing, training and maintenance

German Appropriate Technology Exchange (1980) *Helping People in Poor Countries Develop Fuel-Saving Cookstoves.* Produced by Aprovecho, Eugene, Oregon, U.S.A.

Chapter IV: Promotion and Dissemination

Sales and Subsidies: Boiling Point Issue No. 30, April 1993.

Practical Tips for a Marketing Strategy (pp. 31-32)

PART III

THE INDUSTRIAL SECTOR

9. DEVELOPMENT PERSPECTIVE AND ENERGY EFFICIENCY: Need for a Broader Perspective.

9.1 Introduction

9.1.1 Part III concentrates on examining the links between industrial sector activities, energy efficiency and poverty. It highlights the policy implications for developing energy efficiency programmes, identifies and examines energy intensive industrial activities which could be targeted for intervention.

9.1.2 This chapter shows that, in the context of developing countries, there is a need for a broader perspective within which energy efficiency measures have to be located. Drawing on evidence from Asia and Africa, it argues that focusing only on combustion related pollution will not produce any discernible environmental benefits. However, an energy-led initiative encompassing the issues discussed could improve ambient and work place pollution.

9.2 Energy Efficiency

9.2.1 Energy efficiency as a concept has a range of interpretations. At a strictly technical level, energy efficiency is a measure of useful energy output compared to energy input. This is conversion of electricity to other forms of energy, say to electric light, it would be the energy value of the illumination compared to the energy input to the lighting device. For fuel usage, energy efficiency would be the energy output as heat and/or power compared to the energy input as defined by the fuel mass and gross or net calorific value.

9.2.2 Measures to increase energy efficiency of process operations have been recognised as beneficial both in terms of cost savings and to reduce the demand for energy resources. This monitoring and improving energy efficiency for the whole range of energy using operations has attracted much attention. In developed countries, this activity was initially promoted strongly by government incentives and support mechanisms, but it is now much more market driven activity. However, as discussed in the previous chapter, as the resource issue has taken more importance, the relevance of energy efficiency for conservation of energy and as a means to address target obligations for CO_2 emission reductions has increased.

9.3 Developing Countries and Associated Issues for Technological Change

9.3.1 Research and experience in developing countries have shown that there is considerable overlap of issues when dealing with industrial pollution. The approach to the problem is conditioned by the size of industrial units. There is general agreement that in large industries issues of energy efficiency can be separated and dealt with. The large firms have the financial and technical ability to do so. In small and medium sized units the problem is more complex. In these units inefficient energy use is one of several reasons for air pollution. Other equally important contributory factors are absence of waste management, poor work practices and housekeeping, inefficient resource use, disregard and/or lack of health and safety standards and low environmental awareness.

9.3.2 To achieve discernible environmental improvements a broad perspective is called for. Experience shows that whether the objective is to reduce pollution through improved waste management or enhanced efficiency in energy and/or resource use, the approach to the problem has to acknowledge the inter-connectivity of the various factors contributing to pollution.

9.3.3 Section 9.4 sets out a detailed case study from India and section 9.5 provides additional empirical evidence from Asia and Africa, on which these inference are based.

9.4 Evidence from India

9.4.1 *Lead Smelting Units in Calcutta:* This case study (Dasgupta: 1997) details the process flows in an industry with the aim to highlight the inefficiency of resource and energy use, poor work practices and absence of waste management practices which together contribute to air pollution. The evidence presented here is based on an in-depth analysis of the attempts made by a cluster of units, threatened with closure, and by the environmental agency to reduce pollution so as to comply with the environmental standards, within one year (August 1994-August 1995).

9.4.2 Lead smelting is a wide spread activity in India employing thousands of low income workers. Size of units range from employing 10 to 50 workers. Most of these units, initially located outside the urban areas, have now been swallowed up by urban expansion of low income households. The raw materials used by these units are lead plates from old batteries, coal and charcoal..

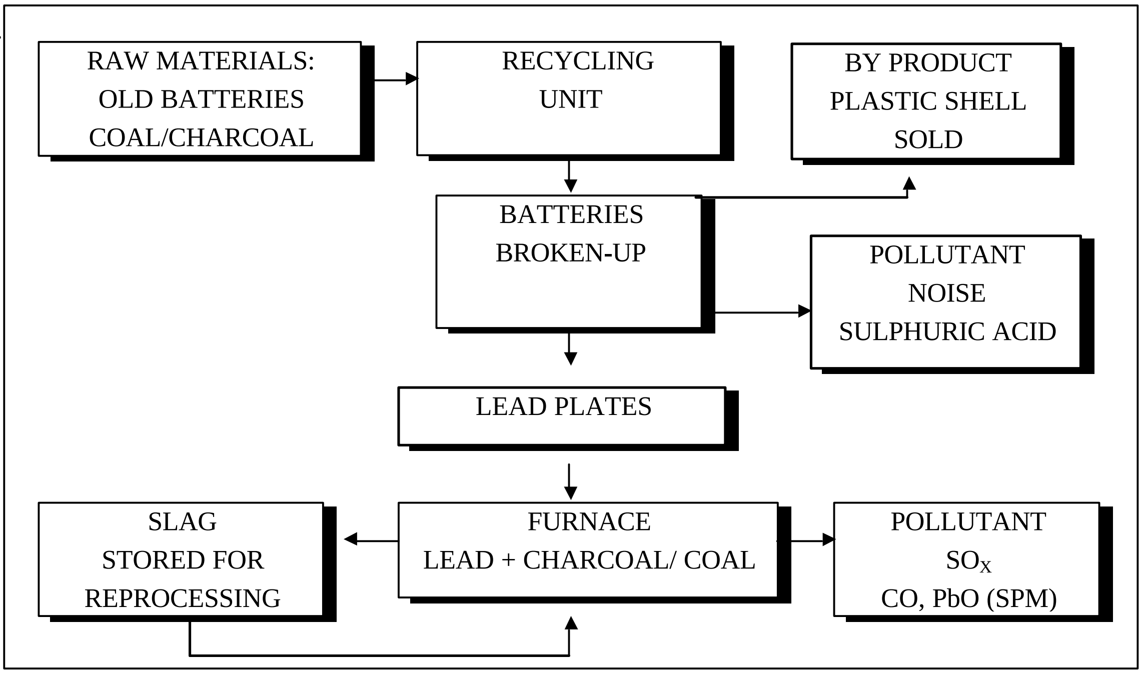
9.4.3 *Furnace:* A simple brick structure with four firing pits i.e., four doors to the same furnace with no separating walls. There is one chimney stack for all four firing pits. This means that opening any one door affects the efficiency of all the others. All pits are not always loaded before starting the furnace. Loading often takes place while the furnace is on.

9.4.4 *Process:* The plastic shell is cracked open and the lead plate removed. The plates are then mixed with coal and charcoal and smelted in the furnace. The lead which separates from the slag is collected and made into ingots. The slag is stored until a substantial amount has built up. It is re-smelted several times for further extraction. (See Fig. 9.1)

9.4.5 *Pollution:*

- high level of noise pollution when the batteries are broken up;
- sulphuric acid is released when batteries are broken up. This flows into drains and surrounding areas contaminating land and water;
- sulphur dioxide and carbon monoxide are released during the smelting process;
- lead oxide forms a major part of the suspended particles released and the fine dust is easily carried by the wind;
- inefficient use of furnace results in excessive smoke and pressure in the chimney stack, forcing some of the smoke back into the workplace; and
- seepage from the slag stored for re-smelting contaminates land and water.

Fig. 9.1 Process Flow Employed to Recycle Lead from Old Batteries



9.4.6 Following the court orders and the threat of closure in August 1994 most of the 24 units covered by the orders had installed some form of pollution abatement equipment by August 1995. At the same time engineers from the West Bengal Pollution Control Board worked to reduce the inefficiency associated with furnace use and its design. (They estimate the furnace efficiency can be increased by 75%). Despite the control measures there was very little change in the level of air pollution. Reasons being, either the equipment was used only when inspectors came around (maintenance cost are very high) or it was already malfunctioning due to improper use.

9.4.7 *Constraints to success*:

Poorly informed and difficulty in handling new information

- The factory owners did not understand the technical specifications and implications of pollution standards and no one bothered to explain.
- The firms selling the equipment were in for quick commercial gain. No technical survey or monitoring was undertaken. Owners could not ask the right questions.

Low environmental awareness

- The owners were not really interested in pollution reduction and sought the cheapest rather than the most effective. Most owners have little education and are poorly informed.

Unused to complying with specifications

- It is not clear whether the limitations and maintenance requirements were clearly explained, or it was ignored, as in most cases the equipment malfunctioned. (e.g. bag filter: all four pits were fired as the same time whereas the equipment installed is designed to take the load of one).

Limited institutional resources

- Lack of technical advise from the environmental agencies. Reasons: (i) inspectors over-stretched and do not see providing advice as one of their tasks; and (ii) no ready technical solutions.

- Regular monitoring too expensive.

Most owners are very bitter about their experience as considerable investment has brought no benefits either in terms of environment or profits.

This case study demonstrates that there is considerable scope for increasing the thermal efficiency of fuel use in these units. However, to have any impact on the overall pollution situation, it would be essential to improve work practices, advance environmental awareness and introduce waste management techniques.

9.5 Additional evidence:

9.5.1 Much of the research on environmental improvements in small scale industries focus on management of effluents rather than on emissions. This is perhaps because the source and the impacts are more easily identified and hence easier to deal with. However, some of the findings of these studies/experiences with respect to introducing cleaner technology and improving waste management are also valid for emission control through enhanced efficiency. These findings relate to constraints to implementation arising from inherent characteristics of small industries. Some of these inferences are summarised below.

9.5.2 *Hong Kong*: Most small factories (<20 workers) are located in multi-storey buildings where installation of pollution control equipment is difficult. Arrangements were made to collect waste free of charge and treat waste centrally. 8000 units registered. All agreed to store their chemicals on site and arrange proper disposal. Factors contributing to success are: extensive consultation with trade associations, awareness raising and information dissemination; and combination of "carrot" (free collection/ treatment) with "stick"(heavy penalties for non-compliance), (Lei & Young 1993).

9.5.3 *India*: Chandak (1994) notes that pollution reduction programmes for paper and pulp, textile dying and printing and pesticide formulation were easier to implement in large scale industries than in small units. The author attributes it to barriers inherent to enterprise size, i.e., organisational, technological and economic, among others.

9.5.4 Evidence from Bangkok (Lohwongwatana *et al* 1990), Cairo (Hamza (1991), Hong Kong (Chiu & Tsang 1990; Mexico (Mendoza (1991) India (Tikko: 1992) shows that lack of space is an important constraint to technological change and to improved waste management.

9.5.5 In some instances the size of the unit itself can be a constraint to technological change. In Asia, rice processing is one of the largest sectors in peri-urban and rural area. It recycles the waste product (husk) as a fuel. However, studies have indicated that the thermal efficiency, from a combustion point of view, is grossly inefficient. A study by the EC-ASEAN Cogen Programme (AIT, 1994) for Indonesia, Malaysia, Philippines and Thailand was undertaken to establish the scope of enhancing the efficiency of fuel. It concluded that overall product capacity was dominated by small scale operation, where the average rice mill output was only 560 tonnes per year. Similar pictures for rice processing have been described for Sri Lanka (Hollingdale & Coote, 1991) and for Bangladesh (Tariq 1998). Also this same pattern for the rice processing sector is evident from the Indian statistics reviewed for this report. Though several technological options have been developed, the constraints to uptake have not been identified.

9.5.6 Lin (1994) with reference to Hong Kong stresses the importance of developing "win-win" technologies that eliminate pollution control costs while also reduces manufacturing costs. The UNIDO (1996) project DESIRE (Demonstration in Small Industries for Reducing Waste), in India, also stresses the need to highlight the gains, in terms of increased efficiency, higher material recovery and lower waste generation, from technological change. Segments of the industry also realise its importance. In Surat, Gujarat, a voluntary organisation 'Waste Minimisation Group-Surat' has been set up by technical experts from various chemical industries. Some of their objectives are: to increase environmental awareness; to create awareness of source reduction of costs and of pollution by optimum utilisation; to create awareness of cost reduction that can be achieved by efficient utilisation of water and energy (UNIDO: 1996).

9.5.7 Scott (1998) in a review of Environmental Impact of Small Scale Industries in the Third World noted that while they do not have significant environmental impact from a national point of view, they can have severe detrimental effects locally. Following an in-depth analyses of brick making and gold mining industries in Zimbabwe and textile dying in Bangladesh, he notes that "policy, organisational and technological approaches are possible means to improve the environmental performance of small-scale industries". Furthermore, identification of constraints and incentives to adoption of mitigation measures or development of cleaner technology requires the investigation of both socio-economic and regulatory context in which small producers operate.

9.6 The Socio-Economic Context

9.6.1 The social and economic roles played by the small industries in developing countries help to explain why several over-lapping issues have to be tackled to achieve pollution reduction through technological change.

9.6.2 At the macro-economic level developing countries are characterised by structural dualism (long term co-existence of modern and traditional; of a rich elite and mass of illiterate poor), persistent long term unemployment and poverty. Most developing countries in Asia have a modern industrial sector, with reasonably well developed factor and product markets, capital stock, professional management and ability to change. The Centre for Science and Environment in India (1985) noted that this sector has the means to acquire the technology and the expertise necessary to improve environmental management. This part of the industrial sector is similar to that found in other countries and has characteristics that fall outside any particular national socio-economic context. Issues of how far producers externalise their costs of pollution will fall within the framework of national environmental legislation.

9.6.3 As a matter of national development policy most developing countries encourage the small scale sector because of its employment generation capacity. This is done through subsidies, credit facilities and product protection. With its low barriers to entry, it is expected to generate livelihood for those with limited resources, knowledge and skills. Thus, the preponderance of the small-scale sector of industry is a more identifiable attribute of the developing countries.

9.6.4 It is the lower levels of resources (human and financial) associated with this sector that modify the relations between capital, labour and technology and differentiate it from large scale manufacturing. It makes environmental management in small industries operationally more complex.

9.6.5 Some inherent characteristic of small scale industries which impinge on technological change are:

(a) The choice of technology is adapted to availability of capital, space, raw material and skill-local and in the family (Sethuraman: 1992).

(b) Available knowledge and information base is low. This is reflected in poor work practices and in the disregard for health and safety aspects. Additionally, the low exposure to information means limited ability to handle new information as demonstrated in the case of lead smelting units.

(c) Possibilities that managerial and technical abilities among owners and managers are likely to be low (Sethuraman: 1992).

(d) Limited resources means predominance of short term profit maximisation over long term gains. This would make it difficult to sell the standard 'business' argument that greater efficiency and higher material recovery leads to improved profits in the long run.

(e) Smaller units have a lower capital-output ratio compared to a competitive large unit (Sandesara: 1992). This often leads to lower investible capital in the long run.

9.7 Conclusion

9.7.1 The evidence provided in this chapter highlights the difficulties of achieving environmental improvements in small industries. The background and the compostion of this sector calls for a comprehensive approach to problem. The findings of this chapter are summarised below.

Findings

1 The need for a broader perspective implies that focusing only on combustion related pollution will not produce any discernible environmental benefits. However, an energy-led initiative encompassing the issues discussed above could improve ambient and work-place pollution.

2 Pollution control and energy efficiency in small industries cannot be expected to follow from simply superimposing models that have been used for large industries. These operations are still essentially rooted in a socio-economic culture that has largely been displaced in the developed countries.

3. It is important to develop 'win-win' strategies that eliminate pollution control costs and also reduces manufacturing costs. It is crucial to inform industry of economic gains that could be made in terms of increased efficiency, higher material recovery and lower waste generation from technological upgradation and process improvements. It would help counter their negative perceptions and attract their attention.

10. ENVIRONMENTAL IMPROVEMENTS IN SMALL SCALE INDUSTRIES: Benefits the Poor and the Industry.

10.1 Introduction

10.1.1 One of the objectives of this study is to identify those energy intensive industrial activities where enhanced energy efficiency would lead to environmental improvements, which in turn would generate direct socio-economic gains for the poor and the industry. Based on extensive literature review, wide-ranging discussions with research organisations, practitioners and policy makers in India, it is *argued that (i) environmental gains in energy intensive sub-sectors of small scale units, employing large number of low income workers and which form clusters in proximity to low income housing, could have considerable impact on poor workers and on the neighbourhood; (ii) the environmental gains will enable compliance and remove threat to livelihood opportunities from closure of industries; and (iii) the efficiencies achieved would increase returns for the owner in terms of savings in input, reduced waste generation and lower costs of pollution control.* However, to maximise the impact of any energy-led initiative a broader approach encompassing other issues like good house-keeping, good work practices and overall waste management, needs to be developed

10.1.2 The next chapter identifies energy intensive sub-sectors of small scale industries. This chapter focuses on setting out the bases for the above argument. It first shows why the emphasis is on small rather than large scale industries before discussing why benefits could flow to the urban poor (section 10.3) and to industry (section 10.4) from energy-led initiatives in small scale industries.

10.2 Large Industries

10.2.1.1 There are three sets of reasons for not focusing on large scale industries. *One*, the direct impacts on poor groups, of environmental improvements in the limited number of large scale industries, is difficult to establish. *Two*, the work-place health and safety standards are adhered, the workers are well-paid and protected by strong unions; and *three*, large manufacturers have the financial ability and the in-house technical expertise to enhance efficiency in fuel and resource use and to comply with environmental standards.

10.2.1.2 *Large industries and poverty impact*: The dispersed pattern of their location and the scale of operation means that the impacts of any improvements would be realised over a large geographical area covering various income groups. This means that all economic groups would gain from such improvements. Hence, the direct impact on poor groups is difficult to identify and assess.

10.2.1.3 *Workers in large industries*: In sharp contrast to the conditions which exist in the small and medium sector units, the workers employed in large industries are relatively better off. They benefit from higher wages, pension schemes, insurance against injury and the protection of strong unions. They are often provided with subsidised housing, particularly in the public sector. Work place health and safety standards are generally high. The term 'labour aristocracy' is sometimes used to describe workers in large scale modern manufacturing units.

10.2.1.4 *Higher compliance:* Large manufacturers have the financial resources and technological expertise to comply. Higher efficiencies could be achieved through a mix of market and non-market inducements. However, Dr. Maudgal, Senior Advisor- Clean Technology, Ministry of Environment and Forests, noted that the government first needed to correct market distortion by removing subsidies on power, main raw materials and water. Hence assistance to this sector cannot be justified.

10.2.1.5 Additionally, though there are laggards in the industry, large manufacturers have generally tended to comply because (i) large firms are highly 'visible' and pollutants can be traced back to their source. In the state of Gujarat, the State Pollution Control Board is developing a Geographical Information System to monitor effluent discharge; (ii) large firms producing brand names do not wish to attract negative publicity; (iii) the government owns (part of) a substantial number of large scale firms. This provides potential leverage to impose environmental compliance; and (iv) there is an increasing realisation that there can be economic gains through waste minimisation and increased efficiency of fuel and resource use.

10.3 Energy-led Initiatives in Small Industries and Poverty Links

10.3.1 Energy-led initiatives leading to environmental improvements could generate benefits for the poor and the industry. This section examines the poverty impacts while Section 10.4 looks at the benefits that could accrue to industry.

10.3.2 Environmental improvements can generate benefits for the poor because:

(i) In Indian cities, the intra-urban spatial differences in pollution impact is deepened by the clustering tendency among small and medium industries;

(ii) Small scale industries, which employ thousands of low income workers, are being threatened with closure for non-compliance but lack the means to deal with the problem. Enabling industry to comply would remove this threat to livelihood opportunities; and

(iii) These workers are exposed to high levels of work place pollution.

10.3.3 *Intra-urban differences in pollution impacts and clusters of small industries*

10.3.3.1 As noted in Chapter 3, urban growth tends to group enterprises in cost effective spatial configuration. Cheap housing and industrial activities tend to be located on lower cost land in urban area. There is evidence that this spatial juxtaposition of industrial and low income housing create special environmental and health risks for the poor. Additionally, in certain locations the externalities of urban production are disproportionately borne by the poor.

10.3.3.2 In Indian cities this spatial configuration, and hence the differentiation, is intensified by the tendency of small and medium industries to form clusters. Industrial clustering as a process and industrial clusters[★] as spatial entities have existed in India for centuries as efficient business and production systems contributing to the development of small and medium enterprises. These clusters have been defined as local agglomeration of industrial units manufacturing or providing similar type of goods or services with well established linkages with service providing units. The original reasons for natural clustering ranges from proximity to market, availability of raw material and specific skills.

★ Industrial clusters are discussed in detail in Chapter 12 in the context of environmental initiatives.

There are induced clusters, for example the automobile component industry at Gurgaon, which developed following the setting up of public sector car manufacturing unit. These are usually located in planned industrial zone and are not considered in this study.

10.3.3.3 Some natural clusters were initially located outside the cities and have been subsequently swallowed by mixed land-use and/or low income housing expansion. Some have always existed inside cities. Some examples are, the foundries at Howrah which developed at the turn of the nineteenth century to supply the jute mills and then Indian Railway; the cluster of traditional glass industry in Ferozabad; the footwear industry in Agra where 5000 units thrive; the lock making clusters at Kanpur and Howrah; electric fan production in Calcutta; hosiery knitting clusters in Tripur and Calcutta. Size of clusters vary from about 20 units to several thousands. UNIDO (1998) has identified 138 cluster, each containing more than 100 units. It estimates that there are 350 modern SME clusters in urban areas and 2000 artisan based rural clusters. Thus, industrial clustering is an important spatial phenomena.

10.3.3.4 Of relevance to this study is the fact that most of these natural clusters are characterised by old technology which has not been improved for generation, inefficient use of fuel and raw material, lack of scientific control of production processes, unreliable product quality, high waste generation, no housekeeping, poor work practices and high work place and ambient pollution. Since the early 1990s a school of thought has argued that small enterprises are technically less efficient than larger enterprises and therefore likely to produce more pollution per unit of production. This is largely accepted in India today, where the general understanding is that while labour and capital productivity in small industries may sometimes be comparable to large industries, its material productivity is usually lower, resulting in more pollution per unit. Bhalla (1995) estimated that while SSIs contribute to around 50% of industrial production, their share of industrial pollution amounts to 65%.

10.3.3.5 From field experience all practitioners and researchers agree that high levels of air pollution are associated with some of these clusters, exacerbating the intra-urban differentiation of pollution impact on the poor. Hence, the workers involved and the surrounding neighbourhood of poor residents could directly benefit from reduction in air pollution which is detrimental to health.

10.3.3.6 It is important to note, that though there is a consensus that poor live close to polluted neighbourhoods and therefore suffer disproportionately, no socio-economic - environmental research has been conducted to establish the affect/associations of cluster based pollution on urban poor.

10.3.3.7 (A methodology to address this gap in research has been developed by this study team in discussions with TERI. This is described at the end of this chapter. A better understanding of the links would allow environmental proposals to incorporate wider social issues to benefit the poor and at the same time, to guard against the dis-benefits of technological change).

10.3.4 Small scale units: threat of closure jeopardises livelihood opportunities

10.3.4.1 Section 5.5.4 noted the more stringent environmental enforcement in recent years. Small and medium industries have been at the centre of these developments and are threatened with closure. This makes it imperative for these industries to improve their energy and environment performance. This is fundamental to ensuring their survival and to maintaining the livelihood opportunities of a large segment of the urban poor. TERI notes that there are many energy intensive sub-sectors where the energy cost forms a substantial proportion of the total production cost, yet these units are characterised by low energy efficiency. Thus there is considerable scope for energy-led initiatives.

10.3.4.2 However the problem arises because unlike the large scale sector small industries lack the financial and technical expertise to deal with the problem. A World Bank report (1991) concluded that pollution problems are more acute among SSI. Some of the reasons for low financial and technical ability are:

- Given the structural dualism and the limited employment generation capacity of large industries, the small scale sector in India is expected to generate employment for those with limited skills and resources[•] . It is encouraged through subsidies, credit facilities and product protection.

- Small industries are predominantly family run businesses.

- This brings to the sector lower levels skills, literacy and resources. Consequently the available knowledge and information base is limited. Business decisions are more influenced by the family's contacts and perceptions. Reaction to, and interpretation of, new information is greatly influenced by the owner's socio-economic background.

- According to Sethuraman (1992) the choice of technology is not a technical decision. Technology is adapted to availability of capital, space, raw materials and skills available in the family or locally. This contrasts with the behaviour of large enterprises which choose optimal combination of resources in view of the technology used.

- The technology used is often the cheapest and very rarely upgraded. A survey of 130 small firms (Dasgupta 1998) in Delhi showed that investment was made to expand production using the same technology. There were no instances of technology up-gradation.

- The dominant short-term profit maximisation behaviour leads to lower income in the long run. This often lead to limited investible surplus.

- Small industries pay little or no attention to work-place health and safety conditions, to house-keeping or good work practices.

10.3.4.3 Thus the small industries, which contribute substantially to industrial pollution are now threatened with closure because they are unable to understand and/or meet the environmental standards. More important for this study is that they employ 48% of the industrial workforce in the manufacturing sector. The estimated employment provided by this sector is 16.72 million (DCSSI: 1998). The position of the workers in small industries is extremely precarious and vulnerable. The wage market is poorly developed and wage rate is often arbitrarily determined by the owner. There is no written job contract. This means, they can be fired any time without compensation jeopardising the livelihood strategy of the entire household.

10.3.4.4 An analysis (Dasgupta 1998) of the closure of 1328 small and medium industries in Delhi estimated that 125,000 workers had been made unemployed. None, except the workers in a Government of India enterprise, received any compensation. Workers interviewed noted that most

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[•] This does not include the small electronic and information technology sub-sectors.

were the main bread-winners in the household. Loss of main source of income had severely weakened the livelihood strategies of their households and put extra pressure on other earners and the women.

10.3.5 *SSI workers are exposed to high work place pollution*.

10.3.5.1 Even though small enterprise growth is central to India's developmental strategy, little or no attention has been given to the appalling working conditions found in these enterprises. This is extremely well documented by researchers. In addition to poor wages and insecurity of job tenure, inefficiencies in production processes, poor fuel and material recovery, high levels of waste generation (emissions and effluents), the absence of good house-keeping and dumping of waste means workers are exposed to high work place pollution. Consequently employees suffer poor health which often limits their ability to work. Workers interviewed in glass, lead and acid processing factories in Calcutta claimed that they had to take a year out from work every three years (GHK/ODA: 1994).

10.4 Energy-led Initiatives and Economic Gains for Small Industries.

10.4.1 It has been shown (pp 75) that there is limited awareness of gains that could accrue to industry from increased efficiency, technological upgradation and process improvements. Benefits of increased efficiency are two fold: one, higher return per unit of input; and two, reduced waste generation and therefore lower pollution load.

10.4.2 *Higher returns*: The Sri Lanka case study demonstrated the potential for annual fuelwood savings for industry (Table 5.5). Increase in thermal efficiency from 50% to 70% could generate potential fuelwood savings of Sri Lankan Rs. 509.9m. The experience of Waste Minimisation Circles in India (discussed in detail in Chapter 12) shows considerable savings. Table 12.2 shows that minor changes to technology, fuel switching (replacing coal with waste product **-** bagasse, in paper and pulp industry), and to work practices (covering kerosene tank to reduce evaporation and loss) can lead to substantial savings on fuel and other input costs. In the metallurgy industry (discussed in section 12.3.3.5) the shift from batch furnace to continuous production furnace generates 20% fuel savings, ensures uniform product quality and reduces work place pollution.

10.4.3 Increased return and lower bills do not however, mean an increase in the wages for the workers. The wage rate change will be determined by shifts introduced in the labour market folowing technological changes. It could create a demand for more skilled workers. This could either be met by retraining workers already employed or by replacing them with skilled workers. In the first instance the workers would be better off, but in the second, the displaced workers could slip further down in the labour market.

10.4.3.1 *Lower pollution load*: Improved efficiency of fuel would mean proportionate decrease in fuel usage. This would lead to overall reduction in waste generated. The demonstration unit set up by TERI in Chamrail (Howrah) replaced a traditional front-loading furnace with a divided blast cupola with heat recovery system (see section 12.3.4). This has resulted in 20% fuel savings for the unit and a proportionate reduction in emissions. This could have implications for subsequent end-of-pipe measures.

10.4.3.2 It is pertinent to note that, in India, the present subsidies on fuel and some industrial raw materials are a dis-incentive to enhancing efficiency. However, over a period of time, in keeping with the economic reforms, all subsidies will be reduced. This will make it important for industry to address the problems of inefficient fuel and resource use. Another component of economic reforms is the de-regulation of the power sector. Privatisation is expected to increase revenue collection and the tariff to reflect the true cost of electricity generation and use. This will have major implications for small industries who at present either avoid paying their bills or ignore the cost.

10.5 Conclusions

10.5.1 The analysis in this chapter shows the need to target small polluting industries. The survival of a large segment of urban poor depends on how effectively the small industries are able to tackle their environmental problems. Reducing pollution at the cluster level will also benefit the workers and the local population in terms of improved environment. Industry can make considerable gains from increased efficiency of resource use. However, it is important to demonstrate these benefits.

Findings

1. **Reducing intra-urban differentiation in pollution impact can benefit the poor communities affected. In India this differentiation is deepened by the clustering tendency of small industries. This provides a clearly identifiable spatial unit for poverty-environment initiatives.**

2. **The people who participate in the manufacturing sector are not the 'poorest of the poor' but the workers in the small scale sector constitute an extremely vulnerable segment of the society. Insecurity of job tenure, appalling working conditions and threat of closure and loss of livelihood make them an important target group.**

1 **Communities of low income housing with low levels of empowerment but subject to high levels of industrial pollution form an equally important target group.**

2 **Both these groups can benefit from initiatives which aim to increase efficiencies and to reduce overall pollution.**

3 **Benefits of improved environment are lower environmental health risks and lower incidence of respiratory related illness. This often translates into ability to work for longer periods and reduced medical expenditure.**

4 **Enabling small industries to meet their environmental responsibilities will contribute to their growth and to the income generation opportunities for the poor.**

5 **Increased efficiency can generate gains for industry in terms of reduced input bills and lower pollution load.**

6 **Expected increase in price of fuel, electricity and raw materials as economic reforms progress, have significant implications for small industries. It is important to enable them to anticipate and to address the problems.**

Note:
Methodology for cluster analysis to examine environment-poverty links discussed in 10.3.2.6

These are likely to be the following elements of activity necessary to apply a modelling approach drawing on GIS techniques and to enable a study of the environmental impact of combustion and airborne pollutants upon the local environment in the neighbourhood of a cluster.

- Access to existing, or generating of new, measurement of air quality standards for surrounding areas, through data obtained from fixed monitoring sites at selected locations and for specified pollutants and levels of accuracy.
- Use of a GIS approach to provide spatial distribution of emitting sources and other aspects of the locality, augmented with satellite imagery as necessary to update basic mapping information - with appropriate level of 'ground truthing' validation.
- Identification of cluster characteristics e.g., number of units, size, etc., of production units which will be the emission sources for the cluster analysis. Necessary measurement of production and outputs, and selected combustion exhaust or pollutant emissions from representative sources, in order to define specific or 'surrogate' emission equivalent from industries.
- Modelling of pollutant dispersal, including use of local climatic characteristics, to provide means of surveying impact of these clusters through use of area source models to show distribution and extent of emission pollution from the clusters.
- Derive socio-economic and demographic data around the cluster through existing statistics/data plus use of survey analysis as required.

Whilst, in the first instance, the above activities might be initiated for a focus on emissions resulting from energy use, it is likely that the approach will have wider applicability for pollution modelling and resource loss prevention. It would be logical to anticipate this wider applicability relative to airborne pollutants and resource waste minimisation from the outset of the work.

11. HIGH ENERGY USING SUB-SECTORS OF SMALL SCALE INDUSTRIES

11.1 Introduction

11.1.1 One of the principle exercises of this study was to identify energy intensive industrial activities. Having established that environmental gains generated by pollution reduction in small industries could benefit the poor, the task in this chapter is to identify energy intensive sub-sectors of small industries which could be targeted for assistance.

11.1.2 This chapter is organised to first describe the analysis undertaken by this study to identify energy intensive sub-sectors. It then describe the methodologies used by other organisations in India to do the same. This chapter concludes with a list of energy intensive sub-sectors of small industries.

11.2 Initial Analysis Undertaken by this Study.

11.2.1 The aim of this exercise was to develop a methodology to identify high energy using categories in the small scale sector. Attempts to obtain any meaningful data proved futile. The last comprehensive census had been conducted in mid 1989. It was hoped that more up to date information pertaining to this sector could be obtained during the country visit to India. However, the Central Statistical Organisation, which is a part of the Ministry of Planning and Programme Implementation, was able to provide extensive data, in electronic form for large scale industries. This was the Annual Survey of Industries 1993-94, issued in April 1997. It was decided to use this data to develop and test the methodology, which could then be applied to data on small scale industries.

11.2.2 Industrial data in India, comes in three tiers with different levels of aggregation. The basis of the data is an industrial code classification by National Informatic Centre (NIC) that has 2, 3, and 4 digit designation which represent decreasing levels of aggregation. This code classification applies to large, medium and small industries. Hence the methodology developed using data on large scale units could be applied to data on small scale industries.

11.2.3 For large scale industries, there are 19 2-digit categories, 199 3-digit categories and 393 4-digit categories. 199 3-digit categories were used as the data on 4-digit categories were not made available. A list of parameters was established and through a process of de-selection 18 categories were identified as high energy using. (The detailed methodology is presented in Appendix C). The applicability of this methodology and the validity and relevance of the results were to be tested in India.

11.2.4 In India, the methodology was discussed at two different fora: first at the group meeting at TERI (see Table 1.1 for names of participants), and secondly, at meetings with the Commissioner and officials of Development Commission- Small Scale Industries. TERI noted that while the methodology developed was rigorous, the last comprehensive census on small scale industries was published in 19811. It confirmed that since then major changes have taken place in this sector due to policy changes and economic reforms. Any results based entirely on these data would give spurious results. DCSSI confirmed that the recent data were patchy and incomplete. Several small surveys and studies have been conducted in the absence of a census. However, a large sample survey was being conducted by the National Informatic Centre which would bring the information up to date. Interview with the

Head of the National Informatic Centre revealed that only production and employment data were being compiled as the sole objective was to establish the contribution of this sector to the national GDP. He also added that the 1988 census was now too dated to be meaningful.

11.3 Energy Using Sectors Identified by TERI

11.3.1 Under a programme funded by the Swiss Agency for Development and Co-operation targeting the small scale sector, TERI has selected high energy using sub-sectors. It first shortlisted 41 4-digit categories as high energy users. No strict procedures were followed. This shortlisting was done on the basis of existing knowledge and field information. It is argued that the importance of any industry sub-sector from an energy view point is a function of both its energy intensity and the total number of units within that particular sub-sector. Hence, the energy consumption and the value of production of these 41 code categories were obtained (Table 11.1). This was cross-checked and corrected by unit based energy audits. Casting and forging units received the highest ranking, followed by manufacture of edible oils and fats and manufacture of glass. These three sub-sectors together account for more than 70% of the total energy use within the 41 sub-sectors shortlisted. To arrive at a national picture, a district-wise break-down of units under each of these 41 categories were obtained from NIC wing of the DCSSI. Clusters of units under each category were identified.

The list of high energy using sub-sectors and their geographical location generated by TERI could be an useful starting point for any future programme on energy efficiency enhancement.

Table 11.1. **Consolidated List of High Energy Using Small Scale Industries Produced by TERI**.

4-digit NIC Code	Name of Industry sub-sector	Total no. of units	Total energy consumption (000' Rs)	Total production (000' Rs)
2021	Artificially dehydrated fruits	55	2618	49820
2023	Manufacture of fruit juice concentrate	217	5576	210601
2026	Canned fruit and vegetables	41	980	66029
2100	Manufacture of hydrogenated oil	166	13954	453554
2110	Manufacture of other edible oils and fat	16400	313443	20015998
2200	Industrial alcohol and blended spirit	39	7950	289318
2311	Spinning and weaving of cotton textiles	641	26250	1552097
2320	Dyeing and bleaching of cotton textiles	64	12366	192982
2420	Spinning, weaving and finishing of wool & silk	138	119	12116
2520	Dyeing/printing and bleaching of jute textiles	2	72	4914
2674	Manufacture of artificial leather	2	159	3324
2749	Manufacture of industrial goods	143	1208	67109
2801	Manufacture of pulp (machine made)	5	559	6120
2802	Manufacture of paper (machine made)	283	9132	214059
2903	Manufacture of industrial leather	207	6357	546195
2909	Manufacture of other leathers	35	549	17736
3002	Manufacture of tyre and tube for cycles.	54	13208	294400
3101	Manufacture of heavy inorganic chemical	940	138768	3659312

4-digit NIC Code	Name of Industry sub-sector	Total no. of units	Total energy consumption (000’ Rs)	Total production (000’ Rs)
3106	Manufacture of basic organic chemicals	133	14358	438791
3141	Manufacture of Toilet Soap	111	1853	197335
3169	Manufacture of fibreglass material	76	1061	61490
3181	Manufacture of explosives	20	447	39566
3201	Manufacture of firebricks	122	27953	123681
3204	Manufacture of clay tiles	1015	149739	718980
3220	Manufacture of earthenware	306	3379	64385
3231	Manufacture of chinaware	550	83069	260858
3232	Manufacture of sanitary ware	111	16253	81553
3233	Manufacture of insulators	84	6195	47260
3311	Manufacture of castings and forged iron	5547	768421	12647128
3316	Manufacture of Tools	111	2169	118439
3317	Manufacture of misc. foundry and forged products	289	8965	325258
3341	Manufacture of brass and rollings	90	2377	178784
3380	Processing of metal scraps	356	71093	2308250
3391	Melting and refining of other metal	120	3094	308418
3433	Manufacture of locks	565	4724	268528
3451	Manufacture of cutlery	273	1618	62731
3718	Manufacture of parts and accessories of locomotives	92	1688	99213
3728	Manufacture of parts and accessories of wagons	276	8630	342246
3746	Manufacture of automobile parts	367	12934	796853
3761	Manufacture of bicycles and frames	82	847	70973
3762	Manufacture of cycle rickshaws	92	115	27964

11.4 High Energy Using Sectors Identified by DCSSI

11.4.1 The government agencies for small scale industries have been forced to be pro-active by the threat of closure to small polluting units. DCSSI commissioned several studies for sub-sectors it considered high energy users. Five studies were assigned to identify:

Energy Efficiency Gaps And Potential For Energy Conservation In
Small Scale Bakery Units
Small Scale Steel Re-rolling Units
Small Scale Plastic Processing Units
Small Scale Glass Production.
Small Scale Ceramic Tableware Units.

11.4.2 These studies were conducted by Dalal Consultants and Engineers Ltd. New Delhi. Though this team was shown copies of the reports no photocopies were allowed. These documents are considered confidential as they will be used to inform the next 5-year plan. This indicates that improving energy efficiency in small industries will be an important component of future SSI policy.

11.5 Findings

1. **Energy intensive sub-sectors of small industries identified in India are:**

   Foundries producing castings and forging
   Glass industry
   Manufacture of edible oils and fats
   Small Scale Bakery Units
   Small Scale Steel Re-rolling Units
   Small Scale Plastic Processing Units
   Small Scale Glass Production.
   Small Scale Ceramic Tableware Units.

2. **Information on the geographical location of sub-sectors clusters is also available.**

12. ASSESSMENT OF CLUSTER BASED ENVIRONMENTAL INITIATIVES IN INDIA

12.1 Introduction

12.1.1 This chapter analyses the environmental initiatives taken by various Indian organisations in the small scale industrial sector, some of which are funded by international lending agencies. Not all focus on energy intensive industries. However, it is important to use the experiences of these projects with respect to introducing cleaner technology and improving waste management to inform energy-led initiatives. The aim of this analysis is to draw out the implications for such an initiative.

12.1.2 There are two common factors in all these programmes. Extensive discussions with environmental agencies, officers from the Development Commissioner - Small Scale Industries, National Productivity Council, TERI and other practitioners showed that there are some scattered attempts to deal with the problem of poor waste management and inefficient resource use in small scale industries. Common to all these initiatives is an implicit consensus on the importance to distance these programmes from environment agencies or anything environmental, even though the primary objective is to improve environmental management. The heavy handed approach of the environmental agencies and the subsequent court orders, which pushed end-of-pipe measures, have generated negative perceptions of environmental management at the factory level and a mis-trust of these agencies.

12.1.3 Another common factor in all these initiatives is a cluster-based approach. There are two arguments for this. One, the demonstration effect of benefits that could accrue to the sub-sector through improvements in resource use and waste management is higher; and two, it is more cost effective than targeting dispersed individual units.

12.1.4 This chapter briefly describes the nature, type and characteristics of clusters of small industrial units. It then discusses the initiatives taken by the following organisations:

1. The State Bank of India.
2. Small Industries Development Bank Of India.
3. Development Commission- Small Scale Industries.
4. Tata Energy Research Institute.
5. National Productivity Council.

This chapter concludes with a summary of implications for this study.

12.2 Industrial Clusters

12.2.1 Neither the central nor the state governments have had any special policy to promote clusters of small and medium enterprises. The industrial policy with regard to this sector has tended to target individual units within selected sectors for policy initiatives. With the increase in pressure on industry to reduce pollution, environmental agencies (government, semi-government and private-sector) have recognised the potential of spatial clustering in rapid information dissemination and therefore in increasing the demonstration effect of environmental initiatives. Several programmes have been studied by this team. All have adopted the ‘cluster approach’ to increase the demonstration effect. The fundamental logic is ‘that 95% are imitators, only 5% are risks takers’. The benefits that can accrue to the industry has to be demonstrated to the majority. This is particularly important as environmental enforcement over the last few years has pushed end-of-pipe measures with industry seeing no benefits.

12.2.2 Development Commissioner- Small Scale Industries, recognised the importance of identifying these clusters and commissioned a study in 1997. It was funded by the UNIDO. The study titled 'Restructuring and Modernisation of Small and Medium Enterprise Clusters in India' provides a review of these clusters. It proposes two typologies, one, based on stages of development and the second, based on relationships of units within a cluster. These provide useful descriptive information. Relevant for this study is the relationships that exist between units within a cluster. These intra-cluster linkages would influence the design of any intervention programme.

12.2.3 There are two main types of linkages - horizontal and vertical. While both linkages are present in all clusters, one set of linkages tend to dominate. Clusters where horizontal links dominate are characterised by units which process the raw material to produce and market the finished products. 55% of the 138 clusters identified by UNIDO belong to this category. Certain products allow all stages of production to be carried out by one unit, for example, sports goods industry in Jallandhar and the manufacture of agricultural pumpsets in Coimbatore. Competition between firms within such clusters would be high.

12.2.4 In sub-sector where the production process requires specialised input and/or process at different stages, then the various stages tend to be carried out in different units. This leads to a high degree of inter-dependence among these firms. Examples of such clusters are found in the glass industry, metal processing and textile processing. It is important to add that entrepreneurs often start a new unit, rather than expand the existing unit. This is to escape the labour laws and to enjoy the subsidies provided to the small scale sector. UNIDO noted that in 17 out of 138 vertical links were dominant.

12.3 Initiatives

12.3.1 State Bank of India (SBI)- 'Project Uptech'.

12.3.1.1 The SBI is a nationalised bank. All nationalised banks are expected to provide cheap credit to small scale industries. The initial policy was to encourage the growth of new units. There was little credit forthcoming for technological upgradation as the success of the lending policy was judged on number of new units started. This policy has come under severe criticism for a long time. The banks investment in technological upgradation marks a shift in its policy.

12.3.1.2 In 1988-89 the bank started the programme called SBI-Project Uptech. The aim was to upgrade the management process, product quality, technology and marketing within the framework of what was attainable by the units. The criteria for selection of clusters were: (i) scope for improvement; and (ii) a substantial number of units in those clusters should have been funded by the bank. A survey was carried out to assess the current status of the industry and the scope for improvements.

12.3.1.3 40-50 units were selected for upgradation from six different types of clusters. The sub-sectors of clusters selected were agro-pump set industry in Coimbatore, diesel engine manufacture in Kolhapur, Huller rice mills in Palghat, foundries in Agra, glass units in Firozabad and automobile component manufacture in Pune. A task force of 4-5 bank officers was deputised along with externally identified technical consultants who were to help the entrepreneurs modernise their units.

Six such projects were carried out. For the first three projects the bank paid for the external consultants, subsequently the units were charged a fee.

12.3.1.4 No information is available on further uptake by other units. As seen in other initiatives discussed below, a top-down technical approach appears to have a low rate of uptake. The methodology used has very little scope and/or opportunity for shop-floor interaction with the owner. The main decision makers are the technical experts.

12.3.2 Small Industries Development Bank of India (SIDBI)

12.3.2.1 SIDBI came into being as a subsidiary of the Industrial Development Bank of India (IDBI) in 1991. An initiative with wide ranging objectives was taken under its Promotion and Development Policy. Among others, it covered creation of awareness of new products; process, technology and skills upgradation; and provision of unit specific modernisation package. It targeted 20 small industry clusters for technology upgradation. The product groups include: locks, textile processing, bicycle, scientific instruments, salt and salt based chemicals, powerlooms, machine tools, rubber products, sea food products, glassware, gems and jewellery, brass and bell metal, leather and leather products, foundries and hand tools.

12.3.2.2 The methodology adopted was similar to that used by SBI where technical experts were brought in to identify and solve problems. The bank's modernisation programmes had mixed results. Expectedly so. However, it blames the failure on "unprofessional working of some selected implementing institutions".

12.3.3 Development Commission- Small Scale Industries

12.3.3.1 Of late the DCSSI has been quite active in pollution reduction in small industries. It has selected to focus on those sub-sectors which are highly polluting and have been threatened with closure, and those which are high fuel users. As noted in chapter 11 it has already undertaken detailed studies of five energy intensive sub-sectors. Unfortunately these documents were not made available. At present, there are two programmes. These have been running for several years, but has not had much success either in terms of uptake or of environmental improvements. The programmes target glass and metallurgy industries.

12.3.3.2 *Glass Industry in Ferozabad*: Mr. Sood Deputy Director - Glass and Ceramic discussed the programme in detail. A cluster of units in Ferozabad was selected as they were threatened with closure. Additionally, they are high energy users. The programme was part funded by the Czech Republic which also sold the improved furnace technology. Three types of furnaces are used in the glass industry- Tank furnace, Pot furnace and Muffle furnace. Heat is also used for screen printing on glass, for grinding and for cutting bangles. There are 1200 such units in the cluster.

12.3.3.3 There are 20 large units which have continuous tank furnaces which employ regenerative heat recovery systems. Some are oil fired, with a majority of them fired indirectly by coal through a separate gasification system. The gasification plants are prone to stoppages, halting all melting activities. There are 75 units using the pot furnace. The design is inherently inefficient and very little effort has been made to improve the basic design. Typical pot furnaces operating in UK and Czech Republic are equipped with recuperative systems. None of the Firozabad pot furnaces employ heat recovery systems and all of them use a central fixed bed of coal to effect melting. Muffle furnaces are used for making bangles. They are open in the front, as a process requirement, and thus operate at a very low efficiency level of 3 per cent. This programme aimed to improve the tank and pot furnace technologies.

12.3.3.4 Since the number of tank furnace users is comparatively small, they were individually targeted to improve the gasification plant. For the pot furnace, the methodology used was to go in with the improved technology and set up a demonstration centre for improved pot furnace. DCSSI then undertook training and information dissemination. Mr. Sood noted that even after several years of information dissemination, the rate of uptake remain very low. Other than subsidised coal, which acts as a dis-incentive, he saw major problems in the project design. Some of the lessons learnt are:

- undertake unit level study first to assess the needs and constraints as perceived by the owners;
- once project infra-structure is set up, identify smaller projects within the cluster, based on the unit level study;
- make efficiency gains in existing technology if possible, then adapt and change;
- demonstrate the benefits at unit level and build confidence in the initiative;
- technology change should come at the end of the programme;
- indigenous technology should be first investigated before importing technology which is difficult to adapt to conditions in small units;
- address issues of house-keeping and process modification in the earlier stages of the programme;
- technology change should not be seen as a one time change;
- a project should establish the scope for continuous absorption of technology ; and
- a project will be successful only if the initiative to change comes from the owners.

12.3.3.5 *Metallurgy industry:* Mr. Singh, Deputy Director - Technology Management, agreed that project design had to be re-assessed to improve uptake. Mr. Singh identified some sub-sector specific constraints to uptake. The methodology used by DCSSI in the metallurgy industry is the same as for the glass industry. The main objective of this programme was help units change from batch furnace to continuous production furnace. The change itself generates 20% fuel saving on average and reduces work place pollution considerably.

The constraints to uptake were financial and market based. *Financia*l: The cost of a batch furnace is Rs 100,000 - Rs 200,000. The cost of a continuous production furnace is Rs. 10,000,000. *Market size*: For the continuous production furnace to be cost effective, a certain minimum level of production has to be maintained. The size of the market supplied by each individual unit is too small to support the minimum production required.

12.3.4 The Tata Energy Research Institute (TERI)

12.3.4.1 TERI is a private sector organisation and is one of the leading energy research institution in India. In 1994, with funding from Swiss Agency for Development and Co-operation, it developed a programme to focus on small scale industries. The strategy is ‘intermediation through technology to enhance efficiency of fuel use in energy intensive sub-sectors’. A cluster approach was adopted to maximise the demonstration effect. The methodology used by TERI to identify energy intensive sub-sectors has been described in detail in section 11.3. Foundries manufacturing castings and forged iron received the highest ranking as they are high energy user, are highly polluting and were threatened with closure.

12.3.4.2 Foundries: There are 4180 foundry units in India. Table 12.1 gives the statewise distribution. An indication of the socio-economic importance of this sub-sector, is that the cluster at Agra, in Uttar Pradesh, provides direct employment to 80,000 persons and indirect employment to 350,000 persons (TERI: 1998).

Table 12.1 Statewise Distribution of Foundry Units

State/UT	No. of Foundries
Andhra Pradesh (DFID partner state)	319
Assam	16
Bihar	118
Chandigarh	2
Delhi	84
Goa	12
Gujarat	611
Haryana	172
Himachal Pradesh	6
Jammu & Kashmir	2
Karnataka	239
Kerala	114
Madhya Pradesh	92
Maharashtra	383
Orissa (DFID partner state)	34
Punjab	642
Rajasthan	8
Tamil Nadu	330
Uttar Pradesh	433
West Bengal (DFID partner state)	563

Source: Process & Product Development Centre, India, as cited in TERI (1998)

12.3.4.3 Modernisation in this sub-sector has been slow and conventional methods continue to dominate the sector. The process used is as follows: The raw material consisting of pig iron, foundry returns and scrap iron are melted in a cupola furnace using coke as a fuel. Limestone is added to the charge material as a fluxing agent. The molten iron from the cupola is taken out through the tap hole for making castings. The slag is removed through the slag hole. The scope for improvement lies in improving the performance of the cupola. Alternative technologies are divided blast cupola; hot blast cupola; induction melting furnace; and arc melting furnace.

12.3.4.4 TERI’s (1998) observations on the existing situation are:

- ♦ cupola melting plants have coke consumption ranging from 10% to 30%. In many cases, neither metal nor coke were weighed;

- low awareness of proper operating practices - this accounted for main differences in operating efficiency of various units;
- cupolas are operated by *mistries*[1] who do not have the necessary theoretical or technical background to control cupola operations;
- the size of most cupolas did not suit their melt capacity. This results in low performance - low blast rates and pressure;
- the quality of foundry coke is poor, with high ash content (30%-35%) resulting in low metal temperature and high pollution;
- there is a absence of quality consciousness in most of the units;
- very few units keep proper production records regarding metal charge, castings and rejects;
- those units using the modified double-blast cupola show considerable improvements - a fuel saving of 20% to 25%; and
- one unit operating with hot blast cupola has the lowest coke consumption in the Agra cluster.

12.3.4.5 On the basis of these observations, Mr J. R. Smith of Cast Development, UK, made the following recommendations:

Short term low cost measures

- Improve awareness of the benefits of proper cupola operations.
- Install simple shop-floor control systems for metal quality and fuel consumption

Short and medium term low cost measures

- Provide technical assistance for foundry persons on

(i) measurement of cupola operating conditions; and

(ii) consultancy advice on necessary improvements.

Medium term moderate cost measures

Modification of existing cupolas to the improved design of divided-blast cupola as recommended by the Process and Product Development Centre. This can result in 20% to 25% fuel saving.

Medium and long term high cost measures

- Installation of fully instrumented cupola system with divided blast and other modifications for mechanised charging system.
- Development of suitable heat recovery system compatible with the technology requirements for hot blast operations.
- Dissemination of improved technology by conducting demonstration projects.

12.3.4.6 TERI decided to focus on the foundry cluster at Howrah, (near Calcutta) in West Bengal because Agra, with its high media attention had already attracted sufficient assistance. A demonstration unit has been set up by TERI at the factory 'Bharat Engineering Works'. A member of this study team visited the factory to assess (i) to what extent the recommendations had been taken up; and (ii) the demonstration effect.

12.3.4.7 TERI approached the industry through its two main associations - The Howrah Foundry Association and the Indian Foundry Association. It also obtained advice from the professional organisation called Association of Indian Foundry-men, Calcutta. The owner of the factory selected

[1] *Mistries* is a generic term used to describe any person who has acquired on-the-job knowledge and skills in an blue-collar profession.

for the demonstration unit is also the President of the Indian Foundry Association. The criteria used for selecting the site for the demonstration unit were (i) sufficient space to build the new unit while the old furnace continued to be operated; (ii) the unit was financially viable and able to make the investment.

12.3.4.8 According to Mr. Dugar, the factory owner, the aim was to develop an energy efficient system, and TERI had succeeded in doing so. The furnace installed is a fully instrumented divided blast cupola with heat recovery system and other modifications for top-loading. Additionally, a venturi scrubber with de-watering cyclone to remove sulphur from emissions had been installed with instrumentation for monitoring. Five workers involved in running the new furnace were trained. No other changes have been affected.

12.3.4.9 This has led to a 20% savings in fuel and reduced emissions. It has lowered the processing time and the output quality is higher and more uniform. There has been a marginal improvement in work place pollution as poor practices continue. The old conventional furnace is also operated.

12.3.4.10 Assessment:

1. It appears that the phased approach recommended by the consultant was not adopted. TERI opted for the long term high cost measure. Further enquiries revealed that there has been no uptake of the improved technology. According to Mr. Dugar the measures involved are too costly and cannot be afforded by the average sized units in Howrah. The owner was reluctant to discuss the actual cost incurred.

2. The unit selected is not only financially strong, it is one of the largest units. It has a turnover of 6000 tonnes annually. This is much bigger than the average unit with a production turnover of 1000 tonnes. This implies that when designing the size of the demonstration unit and when choosing the level of technological improvements it is crucial to take into account the average size of units in a cluster and their affordability.

3. The visit to the factory revealed that though it claims to be part of the Howrah cluster, it was located about 5 miles outside this cluster. This geographical distance is a drag on the other owners who would like to observe the benefits. This reduces the demonstration effect. It appears that choice of site for the demonstration unit is very important.

4. The owner notes that raising awareness of work place practices and of health and safety procedures could be a part of the package.

5. A phased approach, starting with low cost measures could be more appropriate in that it would mean greater participation and involvement by owners and workers from the early stages. This would implicitly be an awareness raising exercise. Additionally, this would also allow improvements in existing furnaces and reduction in emissions even before new energy systems are installed.

12.3.5 National Productivity Council (NPC)

12.3.5.1 The NPC is a semi-autonomous agency of the Government of India. It generates 70% to 80% of its revenue through commissioned research and consultancy. The rest is provided by the Government of India.

12.3.5.2 The project **Waste Minimisation Circles (WMC)** was developed, and is run by, the National Productivity Council. It falls under the MoEF's Pollution Prevention Programme which is funded by a loan from the World Bank. Officers interviewed are directly involved with design and implementation of the project. These include Mr. S. P. Chandak, Director and Mr. M. J. Parvez, Senior Deputy Director, Environmental Division. The WMC concept is for small groups of people of similar but independent production operations in particular localities to get together in a self help mode so as to evolve solutions to common problems. The emphasis is on better productivity, particularly through avoiding waste of raw materials and utilities, including energy. The very existance of WMCs implies that there is percieved mutual benefit in some associated activities. Common external threat to their continuity such as have come with strong environmental enforcement seem to have encouraged this process. Once started they, it shows greater benefits from interchange of ideas and shared experience. NPC has been producing a newsletter called 'Waste Minimisation Circle News'. It is a bi-monthly publication where the participants of WMCs are invited to write and also to disseminate information on constraints, solutions and benefits identified. These newsletters have been acquired.

12.3.5.3 The approach to the problem and the methodology developed by NPC is very different from the technology-led approaches used in other initiatives. The process is more participatory, moves at the pace set by the participants, gives a sense of ownership to the entrepreneurs of the solutions developed and appears to have had greater success, in terms of uptake, than some of the other programmes.

12.3.5.4 Objectives and guiding principles of the programme:

- The hidden objective is environmental improvement and pollution abatement. The marketing objective is - help entrepreneurs enhance returns from their inputs. This is essential to counter the existing perception within industry and the associated mis-trust. Thus, the fundamental task is to sell the idea that industry can increase return to its inputs.
- Encourage self-help. This is important, as there is a strong culture of dependency in this sector. This is largely due to the fact that this sector has been protected and subsidised.
- Maximise the demonstration effect of improvements achieved.
- Flexibility is crucial to the success of this initiative. The participants to be provided with the scope to influence and shape the process and pace of change. Participating in developing a methodology of change gives the entrepreneurs a sense of ownership over the solutions.
- 'Brainstorming' at each stage among circle members should by a key activity.
- One basic requirement of the programme is the application of systematic procedures developed by the NIC programme officers. These include (i) a review of process flows. This is a descriptive analyses of inputs, processes used and the outputs; (ii) These analyses are quantified to see the relationships between inputs and outputs. The results are discussed to identify areas of improvement in terms of price, quality and quantity; and (iii) making changes and improvements.
- Training the programme officers, most of whom are technical advisors, to develop skills as facilitators.

12.3.5.5 Under Phase I of the programme NPC helped establish 10 circles and these subsequently increased to 15. The initiative was able to improve waste management and resource recovery in 6 of the first 10 circles. Phase II has a target of 100 circles.

12.3.5.6 Criteria used to select clusters are: pollution intensiveness of activities; cost of pollution abatement; ease of pollution abatement; potential for waste minimisation; potential demonstration effect; financial health of the sub-sector; technical capacity present in the cluster; and public pressure on the cluster.

12.3.5.7 Methodology:

1. Choose a cluster from the list of clusters identified. The final choice depended on whether there was a contact person in that particular cluster.
2. The local industrial association was then contacted through this person. Entrepreneurs were then invited to talk of their problems. This was difficult, as most were hesitant of talk of their problems in the presence of a competitor. The task of the programme officer at this stage is too facilitate discussion between entrepreneurs and to encourage them to share their problem. Central to this process is ‘trust building’ among entrepreneurs and between them and the programme officer(s).
3. Choice of units: Tiny units with less than 6 workers were not selected. Additionally, a minimum level of infra-structure within the unit was essential.
4. A maximum of 6 and a minimum of 3 entrepreneurs form the first group of participants. In forming this group care is taken to ensure that participants are compatible in terms of size of units, nature and type of processes used. This is to ensure commonality of problem and hence greater scope for sharing knowledge.
5. A cost free review is then undertaken of entire process and production stream. At this stage the entrepreneur is encouraged to explain why he is using certain procedures and processes. Process steps generating waste are identified. Out of these, one process step based on its greater impact on the entire production process and quantum of waste generated is selected for conducting detailed assessment.
6. A detailed analysis of process step identified is carried out. It includes preparing process flow charts, quantification of input-output streams to prepare a material and energy balance, assigning costs to waste streams and reviewing of process to identify causes of waste. The latter is carried out through brain-storming sessions which throws up the reasons as to why certain procedures are followed.
7. Generating waste minimisation opportunities. Introduce ideas/techniques of waste minimisation, like good house-keeping, process control, quality control of material inputs, of recycling of waste and of better use of by-products. The fundamental principle is to “gather the low hanging fruits first”.
8. Selecting workable waste management opportunities and carrying out a detailed feasibility analysis for the selected opportunities.
9. Selecting waste minimisation solutions. The identified options are subjected to techno-economic feasibility and environmental acceptability analysis.
10. The input-output analysis is quantified to indicate improvements in fuel use efficiency and in material recovery. Iterative changes are suggested to the existing technology. The demonstration effect of reduced fuel use and/or better material recovery is that, it is imitated by some of the other members of the cluster. “95% are imitators, only a small percentage are risk takers” (Director, NIC).
11. The initiatives to make technological changes, equipment modifications and finally product modifications are left to the entrepreneur. Once the initiative is taken, appropriate technical

advice is provided. Reduced waste generation makes the installation of pollution abatement equipment more economically feasible. However, the links between amount of waste generated and the cost of cleaning-up has to come from the entrepreneurs.

12.3.5.8 Assessment

Achievements: A review of the information provided in the newsletters give various examples of improved process practice. None of these in themselves appear to be technically complex, and the description of achievements that have resulted are quite credible. They are the kind of improvements that require good process know-how for implementation. However, what seems to have been done is to create a climate whereby operators are given the opportunity to identify improvements and obtain credit and recognition for their efforts. It is also worth noting that this against a background situation in which the cost of utilities is apparently reported to be relatively low due to subsidies, so there may be greater potential for this approach with increased utility costs.

Table 12.2 Energy Efficiency Benefits Reported by WMCs

WMC no	Industry (Location)	Process Measure	Energy Efficiency Benefit
WMC 2	Pulp and paper (Muzaffarnagar)	Coal boiler replaced by bagasse boiler	Steam and power costs down 50% and 30% respectively.
WMC 4	Cotton Dyeing (Ludhiana)	Simultaneous scouring and bleaching of fabric Rinsing and acid treatment reduced	Steam use down 50% Power use down 30%
WMC 5	Electroplating (Ludhiana)	Double plating line installed	Power use down 50%
WMC 10	Manmade Textiles (Surat)	Dye bath reuse 60% production increase on Jet dyeing machine Direct-fired gas replace thermic fluid heating	Fuel savings Fuel and power savings Fuel and power costs down 50% and 95% respectively.
WMC 11	Metal Finishing (Mumbai)	Provide lid for kerosene tank	Evaporative loss of kerosene reduced.
WMC 12	Hotels (Mumbai)	Centralised LPG water heating	Fuel saving Rs 15,000 /yr.
WMC 13	Tannery (Vanniyambadi)	Use of fleshings as fuel	Cheaper energy and waste disposal

Source: Newsletters obtained from NPC dated June 1996; August 1996 and April 1997.

12.3.5.9 Reasons for failure: Mr Chandak noted that the initiative in Panipat targeting heavy furnishing textile industry failed because the sub-sector was financially too strong and was not concerned by public pressure. Their flourishing export business meant that they had no time for improving environmental management. He also added that a sub-sector has to be prepared for change. On the other hand, the lock industry in Kanpur, even though it has an established market with little competition, lacks the dynamism and perception required to undertake change.

12.3.5.10 Institutional Development

12.3.5.11 NPC agreed that at present the initiatives are patchy with different levels of success. On being asked what kind of institutional framework could support programmes like WMCs, Mr Parvez made the following comments:

-The institutional framework should allow complete flexibility on the ground. Flexibility is fundamental to the success of WMC.
- Try to use the specialised technical and research institutions which already exist. Decisions have to be taken as to whether these are to be used as a source of information or as a nodal agency for implementing in their sub-sector. Do they have the right 'mind set'? If not, what needs to be done to change them?
-It is important to raise the awareness at the institutional level.
- Official documentation for small industry has to be made more user-friendly, given the low knowledge base.
- Capability building to train technically qualified individuals as facilitators.
- WMC is still in an experimental phase. It is important to learn from failures and success.

Box 12.1 Summarising the Range of Institutions/Organisations that have been Involved in Different Programmes

Programme development:	State Bank of India Small Industries Development Bank Development Commission-Small Scale Industries Tata Energy Research Institute National Productivity Council
Programme implementation	Tata Energy Research Institute National Productivity Council Private Sector Consultants Development Commission-Small Scale Industries
Technology/expertise	Process and Product Development Centre Product based R&D technical agencies Tata Energy Research Institute National Productivity Council UK and Czech companies
Training	Tata Energy Research Institute National Productivity Council
Funding	Nationalised Banks in India World Bank Swiss Agencies for Development and Co-operation

12.4 Findings: Implications for energy-led initiatives

1. **The need to target the small scale industrial sector for environmental improvements seems widely accepted.**

2. **While all initiatives have used clusters as a spatial unit for their environmental programmes, none have taken into account the poverty impact of environmental improvements.**

3. **The environmental programmes cannot be marketed directly. Rather, they have become the hidden agenda. The key marketing strategy is to focus on benefits accruing to the industry.**

4. **There are high levels of inefficiency in fuel and resource use and therefore considerable scope for improvement.**

5. **Co-operation within the sub-sector and a sense of ownership of solutions is fundamental to success.**

6. **A participatory approach to the problem appears to have a higher success rate, in terms of uptake than a top-down technology approach.**

7. **'Gather the low hanging fruits first' seems an useful principle to follow as this would also demonstrate to the owners at an early stage of the benefits that could accrue.**

8. **An holistic approach to the problem is crucial to achieve overall environmental improvements.**

9. **The experience of these initiatives raises questions about how a demonstration unit should be used. For example, at what stage of the programme would such a unit be appropriate? What should be the size of the demonstration unit? Should it reflect the average size of units in that cluster? Where should a demonstration unit be located?**

10. **For each cluster, in-depth analysis at unit level to assess constraints and opportunities for change seems essential.**

13. CONTRIBUTION OF OUTPUTS

13.1 Recommended Approaches to Energy Efficiency Initiatives in India.

A: Domestic Sector

1. Target kerosene users through health programmes to increase awareness of dangers of using kerosene in a poorly ventilated room.

The majority of low income and poor households in the major cities of India have moved up the ‘energy ladder’ to use kerosene. While this is encouraging, it has moved cooking indoors into poorly ventilated rooms. Some studies suggest that indoor pollution contributes substantially to premature deaths in India. It is likely that women, children and old people will be more affected.

2. Explore potential for low-cost design improvement of kerosene stoves using modern, but affordable material, to ensure better combustion.

Pollution from kerosene is due to incomplete combustion of the fuel and due to design inefficiencies in existing stoves.

Contract local energy research organisation with combustion engineering skills to undertake study.

3. Examine opportunities for supporting improved *chulha* programme in appropriate areas.

Woodfuel is used by the poorest in urban areas, who are often transient and/or new arrivals. They would be difficult to target. Many will probably switch to kerosene due to opportunity cost of woodfuel collection, peer pressure, safety aspects, etc.

The pattern of domestic fuel use in smaller towns and cities is not clear. Probably opportunities for improved *chulha* programme exits outside the major urban areas. Any such programme should take on board lessons learnt form the National Programme of Improved Chulhas whose experience shows that fuel saving is not a priority with the poor.

4. Assist to define minimum exposure limits so that judgement can be made if improved stoves do really reduce the health risks posed by PAH class of compounds.

With increased use of kerosene this has become important. At present there are no set exposure limits which would allow one to assess the health impacts, with respect to these compounds.

B: Industrial Sector

1. Target inefficiencies in clusters of small scale industries to generate benefits for a large group of urban poor and for the industry.

Small scale industries in India have been encouraged to counterbalance the capital intensive, low employment generating large scale industries. It has provided livelihood to those with limited skills and resources. The sector is resource poor in terms of financial strength and technical expertise. The efficiencies of energy and resource use are low and waste generation high. Pollution per unit of production is higher in small industries than in large factories.

Some sub-sectors of small industries are threatened with closure for non-compliance of environmental standards. This has jeopardised the livelihood of thousands of very vulnerable low income workers. These workers may also be exposed to high workplace pollution which affects their earning potential due to associated ill health.

A significant number of sub-sectors threatened with closure are high energy users where energy cost forms a substantial proportion of the total production cost, yet these units are characterised by low energy efficiency. This implies scope for considerable gains for industry and for intervention. (A list of high energy using sub-sectors has been provided in Chapter 11).

The clustering tendency of small industries in India deepens the intra-urban differential in pollution impact. Reducing pollution levels at cluster level will reduce ambient pollution of adjoining low income neighbourhoods.

2. **An energy led initiative where the core objective is to enhance energy efficiency but with the scope to address other related sources of air pollution so as to generate maximum benefits for the poor.**

The link between enhanced energy efficiency and poverty alleviation is through improved environment in which the poor live and work. In small industries, combustion related pollution is one of the contributory factors of air pollution. There are bounds to what environmental gains can be achieved by targeting only energy inefficiencies. To achieve an overall reduction in air pollution which will mean improved environment for the poor, it is essential to address other sources of pollution like process inefficiencies, poor housekeeping and lack of waste management.

3. **Target the large number of vulnerable low income workers in small industries and those living adjacent to highly polluting clusters of industries.**

The workers in small industries, are not the poorest of the poor, but do constitute an extremely vulnerable segment of the society. They fall outside the labour laws, experience insecurity of job tenure; work under appalling conditions; and are now threatened with loss of livelihood. Moreover, because they are not the poorest groups, they fall outside the poverty programmes. The second target group, comprised of low income residents with generally low levels of empowerment, make them equally important as a target group.

4. **Any energy led initiative in small scale industries should incorporate the lessons learnt from other on-going programmes.**

The importance of assisting small industries to improve environmental management has been recognised. The efforts though patchy and limited in scope have important lessons for any future initiative. DFID's energy led initiatives should take on board these lessons. These relate to project design; selection of criteria for choosing target cluster; role and timing of technology change; assessing the relative importance of different sources of pollution; designing programme of activities; and implementation.

5. A participatory approach to enhancing efficiencies in energy and resource use has more scope of success.

The assessment of on-going programmes assisting small industries showed that a technology-led, top down approach has had a lower rate of uptake even though a demonstration unit had been set up. The participatory approach (discussed below) used by the National Productivity Council shows a success rate of 60%. In addition to higher uptake it encourages self-help and gives the entrepreneurs a sense of ownership over the solutions.

6. Assist in institutional awareness raising and capability building.

Large numbers of specialist research and technology design government agencies already exist. Their present role in improving environmental management is limited and unclear. DFID could assist to increase environmental awareness in these organisation and to augment and/or re-orient their capability so that they can play a role in the changes taking place.

7. Assist in developing an appropriate institutional framework which can incorporate the flexibility of a participatory approach to environmental improvements.

With the exception of the DCSSI, the agencies and organisations who have taken the initiative to facilitate change in small industries are not directly responsible for environmental change in this sector. There is no named body which can take a comprehensive approach to the problem and facilitate change. The Pollution Control Boards are monitoring agencies. DFID could assist to build a framework, while it will formalise procedures and recognise commercial realities, must allow flexibility on the ground to allow the application of a participatory approach.

An organisation like DFID could act at either one or at two levels. One, at the cluster level to develop a programme to target a selected cluster of energy intensive sub-sector. Keeping the 'win-win' objectives in mind, the role could be to help design, develop and test methodologies/procedures for participatory environmental initiative in collaboration with national government and private sector agencies. This would not only enable change at the cluster level, but also inform policy design and institutional building. At a higher level, DFID could assist national agencies to change and develop an institutional framework which will support private-public sector partnerships for environmental management in small industries. DFID is already involved at a sectoral level in Orissa, assisting change in the power sector following its de-regulation.

C: Commercial Sector

1. Need for a systematic study and greater understanding to identify poverty links.

The data available in India and other Asian and African countries made it difficult to assess the poverty impacts of enhanced energy efficiency in this sector. The on-going project in Africa showed that the target group was large institutions like schools, hospitals and government institutions. While substantial (50%) reduction in fuel use had been achieved it was not clear whether these gains were being ploughed back to benefit the poor. For example, were schools providing better/more books following reduced fuel cost?

Additional difficulties arose from the nature of the sector itself. The dispersed location of hotels and eating houses make them logistically difficult to target. Easier to target are the large outlets. However, in this case it is less clear who the beneficiaries would be.

13.2 Influencing Policy

1. Put demand management of energy on the agenda.

Demand management is a neglected policy area in India. Assist to develop a demand management strategy at the national level to rationalise and plan fuel use. In the industrial sector, subsidised raw material and fuel is a dis-incentive to improving efficiency of use. Assistance could be provided to develop a strategy which would replace subsidy by instruments (market and non-market) to encourage efficiency of fuel use. For the domestic sector, energy planning should ensure that all sections of the population have access to adequate fuel. Scope for making LPG more accessible should also be considered.

2. Put energy on the agenda of urban development programmes

Urban domestic fuel use is a neglected issue. DFID could assist in the establishment of energy taskforce, with national and state governments, NGOs, research organisations and slum improvement boards. Liase with other DFID-supported initiatives. Energy task force could inform DFID health groups of impacts of indoor pollution.

13.3 Lessons for Participatory Environmental Initiatives

The experience of projects targeting inefficiencies of energy and resource use have important lessons for a participatory approach to environmental problems. These are:

1. The fundamental task would be to convince the industry that they can increase return to inputs from increased efficiency.
2. The team of facilitators should be engineers trained to act as facilitators.
3. Identify a small group of willing factory owners in a selected cluster of units, representing a chosen sub-sector.
4. Take time to break the ice among the participants, as they could be competitors, and to build confidence in the team of facilitators.
5. Encourage self-help to counter the culture of dependency found in this sector.
6. Create an ambience for discussion and exchange of ideas.
7. Facilitate and brainstorm so that identification of problem comes from participants.
8. Provide technical advise to solve problems they have identified.
9. Do not underestimate the knowledge of the entrepreneurs.
10. Move slowly by addressing efficiencies easily achieved: “gather low hanging fruits first”.
11. Once the process of change has been initiated the participants should follow the methodology and procedures set in the programme.
12. Initiatives for technological change, process modification and product change should come from the participants.

13.4 Future Research Needs

1. Study on poverty impact of reduction in subsidy on kerosene:

At present the government subsidy on kerosene stands at 50%. Over next few years this subsidy is expected to be reduced to 15%. This is likely to have considerable impact on the poor and low income groups who have shifted to the use of kerosene as a cooking fuel. The government has no plans to undertake such a study.

2. Study to assess impact of reduction of cluster based pollution on low income workers and residents.

There is a general agreement that the urban poor live close to highly polluted environment. There has been no systematic study to assess the socio-economic-environment link. A better understanding of these links would allow environmental proposals to incorporate wider social issues at the project design stage and to guard against the dis-benefits of technological change.

3. Systematic scoping study to assess the need for an improved stoves programme in India.

Given the limited up to date information on pattern and trend of domestic fuel use at the national level, a scoping study is recommended before any initiative is undertaken.

13.5 Follow up

13.5.1 The research undertaken was limited in that it was not directly linked to any on-going development project and has no committed funds for future follow-up.

13.5.2 Collaborators: The country visit to India showed that there are individuals and organisations with high calibre of skills and experience in research implementation. It is recommended that any future initiative support and build on this.

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APPENDIX A

Preliminary Guidelines for Designing, Developing, Monitoring and Evaluating Household Energy Interventions with a Poverty Focus

1. Identify the problems

1.1 Who are the target groups? Are they amongst the poorer groups in the target area?

(N.B. What level are we targeting? Poor residential neighbourhoods, poor households, or poor women?)

1.2 What are the social or developmental problems of these target groups that have been identified? (e.g. women and children have eye diseases from smoke exposure; women complaining about difficulties in preparing traditional foods due to rapidly increasing prices of fuelwood)

1.3 How were these problems identified? Were the target groups properly involved in defining their own problems?

1.4 Which of these problems can be effectively addressed by improvements in energy management?

1.5 What existing policies, programmes and initiatives are in place which are addressing household energy problems? What are their objectives, what lessons can be learnt from them, and what problems have they encountered?

2. Identify potential solutions

2.1 Are the problems associated with fuel scarcity, or are they associated with inefficient combustion *per se*?

2.2 If the key problems identified are associated with *fuel scarcity*, which of the following management strategies are currently being used in target countries/areas/groups to address the problems? Which of the current strategies are most successful, and why? Are there alternative/additional management strategies that might be more appropriate? Options include:

- Supply enhancement (e.g. through more effective use of waste wood from commercial land clearing)
- Improving marketing and transport
- Encouragement of switching to more efficient fuels (e.g. kerosene, solar water heaters)
- Introduction of improved stoves
- Encouraging changes to household energy management practices (e.g. teaching/development of more efficient fire management practices)

2.3 If the key problems identified are associated with *pollution from inefficient combustion*, which of the following management strategies are currently being used in target countries/areas/groups to address the problems? Which of the current strategies are most successful, and why? Are there alternative/additional management strategies that might be more appropriate? Options include:

- Diverting the smoke (e.g. chimneys, improved building design to increase ventilation)
- Improving burn efficiency through improved stoves

2.4 How do the energy management strategies identified complement and integrate with other planned/existing development strategies in the target areas and for the target groups? Do the energy management strategies need to be modified to maximise complementarity?

IF IMPROVED STOVES ARE SEEN TO BE AN EFFECTIVE STRATEGY, OR COMPONENT OF A STRATEGY, TO TACKLE THE IDENTIFIED DEVELOPMENTAL PROBLEMS (SECTION 11.1.1), THEN……..

3. Refine definition of the problems, through consultations with organisations involved in existing stove programmes (e.g. improved stove users, NGOs, community groups, government programmes, researchers, stove retailers and producers), and with target users.

3.1 Identify the different functions of stoves that are relevant to the target group. These may be a combination of any of the following:

- **Flame**
  - ➪ lighting
  - ➪ ritual significance
  - ➪ entertainment
- **Heat**
  - ➪ cooking
  - ➪ space heating
  - ➪ drying food, fuel and house materials
  - ➪ control of pests in thatched roof
- **Smoke**
  - ➪ preserving and flavouring food
  - ➪ control of mosquitoes and other insect pests of humans and livestock
  - ➪ preservation of house structure (wood, thatch)

3.2 Elicit the relative importance of the various stove functions (e.g. ranking or scoring techniques commonly used in PRA approaches could be useful)

3.3 Develop an understanding of *social issues* that influence or are influenced by stove use:

- **Location** of stove/fireplace. Does this vary seasonally or for special occasions? Why?
- **Fuels**. What types? How is it acquired? Which members of the household are responsible for buying/collecting/processing it? What are fuel costs in time/money, and are they changing? Are there seasonal variations? What are their likes and dislikes about currently used fuels?
- **Cooking utensils**. What utensils are used, where do they get hold of them, which are the cook's preferred utensils and why?
- **Foods**. What are staples and speciality foods? What makes a meal delicious, and what makes a meal bad? Seasonal variations in foods eaten? Do foods eaten vary between households and between members of a household? Why?
- **Cooking practices**. Who prepares and cooks different foods? How are foods prepared and cooked? Why are they cooked in this way? Do practices change seasonally, and/or in times of scarcity?
- **Household structure**. How many people eat at the household, and how often? Do household members eat together?
- **Cultural issues**. Taboos and rituals relating to cooking and eating practices?
- **Perspectives**. What are their views on any problems the have in relation to stove use, cooking practices etc., what would they like to change, and how would they make those changes?

3.4 Develop an understanding of *technical issues* relating to stove use:

- **Fireplace/stove**. What kinds of fireplace and stoves/ovens/kilns are used? What are their advantages and disadvantages? Note dimensions of fireplaces and stoves.
- **Fire management**. If open fire is used, how are fires built and managed, and why?
- **Fuels**. What is used for kindling? What is used for fuel? Seasonal variations? Fuel preparation/processing? Compare combustion characteristics of different fuels. What are local measurement units for fuel (price, weight, length)? Note dimensions, and variation.
- **Cooking utensils**. Variation in pot sizes? Are there standard sizes? Materials used (e.g. clay, metal), and there relative advantages and disadvantages. Are lids used? Why? Note dimensions.
- **Cooking practices**. How long do different foods take to cook, at what heat and flame intensities? Distance between pot and flame, and does this vary for different foods/utensils?
- **Available materials.** What materials are available and affordable locally?
- **Local skills**. Are there local potters, blacksmiths etc.? What materials and tools do they use, and what are there skills?

3.5 Elicit perceptions of target groups and other stakeholders regarding key problems associated with stove use and areas for potential improvement

4. Design and field test a range of prototype stoves in collaboration with target groups

4.1 Design a *selection of* prototypes based on an understanding of the social and technical constraints identified. If stoves are already being used, look for simple but effective ways of improving on existing models. Materials and building techniques should as far as possible be locally available, and as cheap as possible. Designs should be flexible, so that different users can adapt it to suit their needs, and as easy to use as possible.

4.2 Prepare models or drawings of each design, discuss their potential advantages and disadvantages with the target group, and get their opinions on which designs should be tested on a pilot basis in their communities.

4.3 Field test the selected prototypes, and regularly monitor the trials based on the users' own criteria. Do they like the new designs? Are they better or worse than what they are used to? In what way? What improvements could be made?

5. Evaluate prototypes, and draw up profiles for most successful prototypes.

5.1 Ask those members of the target group who took part in the trials to evaluate the different models. Ask them to rank the different models, and their reasons for the ranking order.

5.2 Based on their evaluation, draw up profiles for the preferred stoves. These profiles should include:

- Who the stove is suitable for (what climates, areas, cultures, income groups etc.)
- What are the advantages and disadvantages of the stove
- Constraints to adoption
- How to use the stove most effectively for different functions (e.g. different cooking techniques)

6. Identify methods for promotion, dissemination, production, marketing, training and maintenance

6.1 Production and maintenance. Who is currently producing and maintaining stoves? Who has the potential to do so (materials, tools, skills, financial resources)? Can small-scale artisans be involved? Can members of the target group be involved e.g. can poor women be trained?

6.2 Promotion and dissemination.

- What are effective institutions for promotion and dissemination? E.g. Community groups, NGOs, community shops, places of worship, market places, health workers, schools, communities/individual involved in initial trials.
- What are effective media? E.g. face to face, drama, posters, radio, TV, festivals/feasts, demonstration centres etc.

6.3 Training. Who will train those who produce, maintain/service, and use the stoves? Training of trainers?

Appendix B: Small and Medium Enterprises (SMEs) in India

Background

Second Five Year Plan - 1955

The foundations of the policy for small scale industry were laid in the Second Five Year Plan. In 1956 the government announced its second industrial policy which chose equity as the guiding principle for the development of small industries. It noted that “small scale industries provide immediate large scale employment; offer a method of ensuing a more equitable distribution of national income and facilitate an effective mobisation of resources of capital and skill which might otherwise remain unutilised” (GOI: 1955). Within a higly protected and closed national economy, the SMEs were provided with product protection (to prevent competition from larger units), subdised raw material and cheap credit.

Policy statement: 1977

In the 1970s, India’s swing to an even more socialist stance was reflected in this policy statement. It argued for an expanded role for this sector and extended the list of products exclusively reserved for small industries. Some of the issues relevent of this study are

- whatever can be produced by small and cottage industries must only be so produced;
- the number of products reserved for SSI was increased from 180 to 504, with a further increase to 836 items in 1996;
- special legislation was introduced to give adequate protection to the self-employed in cottage and household industries.
- each district would have a ‘District Industries Centre’ which would provide single-window services

In 1985, taking into account the inflation, the investment ceiling for SSI was raised to Rs. 350,000 and to Rs. 450,000 for ancillary industries.

Economic reforms of the 1990s

The industrial policy of 1991 marked the shift from a highly regulated and controlled economy to a more liberal one. This was initially followed by a higher economic growth, higher productivity, increased job creation and rise in real wages of unskilled agricultural labour. A more recent country study conducted by ILO (1996) observed that employment in the large scale industries is stagnating as productivity gains had been achieved through ....

These changes have had varying implications for the SSI. While sub-sectors like electronic, information technology, automobile components manufacture are thriving. Other sub-sectors have seen the demand for their goods disappear or face greater competition from other sectors The foundries which have been unable to adjust product and process have become uncompetitive. The hosiery knitting units in Calcutta using traditional circular frame have lost their market to mechanised units in Coimbatore. The lock industry in Kanpur, inspite of increasing demand, is stagnating.

Contribution of this sector to the national economy:

There is general perception in India that the contribution of this sector is understimated. It is precisely to this end that the National Informatic Centre is undertaking a survey to obtain the value of production and employment in this sector.
Some statistics according to DCSSSI (1998).

* The total number of registered units stand ar 2,352,000.
* The number of unregistired units are estimated to be 66,200.
* The percentage share of production of SSI to total manufacturing sector is 40.23%.
* The estimated employment provided by this sector is 16,720,000.
* The percentage share of employment of SSI to total employment in manufacturing is 48.8%.
* Household and non registered units together contribute 37%.

Range of products manufactured

This sector produces a wide range of products, from simple consumer goods to high-precision and sophisticated end-products. As ancillaries, it produces a variety of parts and components required by large enterprises. It recycling metals, acids and other chemcials to supply as intemediate goods to industry (large and small) and other users. The sector has emerged as a major supplier of mass consumption goods like leather articles, plastic and rubber goods, paints and chemicals, fabrics and ready-made garments, cosmetics, metal utensils, sheet metal components, soaps and detergents, processed food and vegetables, wooden and steel furniture etc. More sophisticated items include television sets, electronic calculators, microwave components, air conditioning equipment, electric motors, automobile parts, drugs and pharmaceutical.

Government's Promotional Policy and Support Network[1]

New policies/measures for small scale industries (SSI)

In order to help the sector integrate with the industry at large within liberalised economic framework, the government of India has announced new policy measures. In the present context, the following are of particular interest as announced in the year 1991 :

a. The investment ceiling for the purpose of definition of a small unit has been raised to Rs. 6 million (Rs. 7.5 million if the unit concerned undertakes to export 30 percent of its output or if it is an ancillary unit i.e. a firm supplying at least 50 percent of its output to large scale industries).

b. Other investors (including large scale enterprises and foreign investors) are now allowed 24 per cent equity participation in a small scale unit.

c. The Act on Delayed Payments to Small and Ancillary Enterprises has been promulgated. Under this act, buying/mother units will be required to pay interest on delayed payments for supplies bought from SSI units if the payments are delayed beyond the negotiated and agreed upon time period.

[1] This section draws extensively on the document -UNIDO: 1997.

d. The Reserve Bank of India has announced a package of measures to ensure a better flow of credit to the SSI through measures such as expansion of 'single window' loan scheme. Banks are encouraged to open specialised SSI branches and to give greater priority to the sector in their annual credit budgets.

e. Access to inputs has been improved by giving- SSI priority to allocation of iron and steel from public sector undertakings and by removing, obstacles to imports of a ran-e of raw materials and intermediate products.

f. The number of products which are reserved for SSI stands at 836 In 1994. This represents a decrease of only 7 items since the economic reform process has been initiated in 1991.

The Government of India during the pre-liberalisation period i.e. before 1991 had several incentives and subsidies for promotion of SSI sector. These included providing term finance at concessional rates of Interest, hi-her debt-equity ratio, capital investment subsidies to encourage investment in less developed areas, incentives for starting electronic industries etc.

The government promotional framework

The central and state governments in India have together set up an elaborate 3-tier structure for promoting the small scale sector

1. At national level, in pursuance of the recommendations of International Perspective Planning team (1953-54), several institutions have been set up. There is 'Central Small Industries Organisation' (CSIO) which has been renamed as 'Small Industries Development Organisation' (SIDO). During the last three and a half decades, this institution has emerged as the core promotional agency at the central level with a professional staff of more than 13,000 in the year 1993. It consists of 28 Small Industries Service Institutes (SISIs), 30 branch SISIs, 37 extension centres in specific products and 74 workshops as in the year 1993. However subsequently, some of these have been wound up due to their financial 'non-sustainability. These institutions provide technical and management consultancy, organise training programs, conduct techno-economic surveys, prepare project profiles and help prepare unit specific project reports.

   Besides, there are four regional testing laboratories with state of the art equipment and 19 field testing stations which are meant to promote awareness on quality control and standardisation, provide testing, facilities, provide pre-shipment inspection as required by the 'Export Promotion Councils' and organise related training, programs. In addition, there are two 'Prototype Development and Training Centres' (PDTC) to develop new technologies and upgrade the existing, ones. There are a number of other technical institutions that are working closely with SBDO, which are more specialised in the fields of Tool designing, Electronics and Measuring instruments, Prototype development and Handtools etc. Four 'Central Tool Rooms' in Delhi, Calcutta, Bangalore and Ludhiana, have been set up under bilateral assistance programs.

Table A1-Administrative Structure for Governance of Small Scale Industries.

Industry	**Agency**	**Administrative Dept./Ministry**
Large/medium Industries		Dept. of Industrial Policy and Promotion and Dept. of Industrial Development, Ministry of Industry
Small Scale Industries	Small Industries Development Organisation	Dept. of Small Scale, Agro & Rural Industries, Ministry of Industry.
Powerlooms	Textile Commissioner	Ministry of Textiles.
Traditional Industries		
Khadi and Village Industries(KVI)	Khadi and Village Industries Commission	Dept. of Small Scale, Agro & Rural Industries, Ministry of Industry.
Handlooms	Development Commissioner (Handlooms)	Ministry of Textiles
Sericulture	Central Silk Board	Ministry of Textiles
Handicrafts	Development Commissioner (Handicrafts)	Ministry of Textiles
Coir Fibre	Coir Board	Dept. of Small Scale, Agro & Rural Industries, Ministry of Industry

In practice, the small scale industry sector serves as a residuary sector in the sense that all units that fall within a prescribed investment limit and are not recognised in a particular sub-sector are included in the small scale industries sector.

'National Small Industries Corporation' (NSIC) is another important institution set up in 1955 that supplies primarily imported machinery on easy finance terms, provides marketing, assistance, operates 'Prototype Development and Training Centres' (PDTC) in specific fields such as machine tools, injection moulding, leather manufacturing equipment etc. NISIET (now called National Institute of Entrepreneurship and Business Development i.e. NIESBUD) was set up to train and promote personnel, industrial managers and entrepreneurs.

Other national level institutions that are supporting the small scale sector are 'National Research Development Corporation' (NRDC), 'Bureau of Indian Standards' (BIS), 'National Productivity Council' (NPC), 'Consultancy Development Centre' (CDC) and 'Electronic,,. Test and Design Centres' (ETDC). The central financial institutions have also set up the Entrepreneurship Development Institute of India (EDH) at the national level to promote entrepreneurship.

All the above mentioned institutions are largely meant for the modem small scale industry. In order to promote khadi and village industries, a separate high level commission has been set up under the Ministry of Industry. Similarly for the handlooms, handicrafts, sericulture and other non-modem small units there are separate divisions to promote them.

2. At the state level, the governments have set up institutions as follows:

- Small Industry Development Corporations (SIDCS) to develop infrastructure in the form of industrial plots and industrial sheds.
- State Financial Corporations (SFCS) to provide long term credit facilities
- State Exports Promotion Corporations to provide marketing assistance for exports from the small scale sector.
- Technical Consultancy Organisations (TCOS) that provide technical, financial and marketing consultancy to the sector.
- Centre for Entrepreneurship Development (CEDS) and Institute of Entrepreneurship Development (IEDS) have been set up to promote entrepreneurship through training.

3. At District level, in the year 1978, the central government launched a program of establishing District Industries Centres to provide under a single roof all the support services, clearances, licenses and certificates required by the small entrepreneurs. There are more than 400 such centres, one each in a district.

Institutional Finance for Small Scale Industries:

The following agencies through their various schemes provide finance to small scale industries sector under the overall policies and guidelines evolved by Reserve Bank of India.

At the National Level:

1. Small Industries Development Bank of India (Mainly through re-finance)
2. National Bank for Agriculture & Rural Development
3. National Small Industries Corporation
4. Khadi & Village Industries Commission
5. Nationalised Banks
6. Development Commissioner, Small Scale Industries (DCSSI)

At the State Level:

1. State Financial Corporations (SFCS)
2. State Industrial Development Corporation (SIDCS) - Infrastructure/Finance
3. State Co-operatives Banks
4. Khadi & Village Industries Board

At Regional & District Level:

1. Regional Rural Banks (RRBS)
2. District Central Co-operative Banks
3. Primary Co-operative Banks
4. Branches of State level institutions & nationalised banks about 65,000 in number
5. Khadi & Village Industries Commission
6. District Industries Centre (DIC)

The non-government promotion structure

There are three national associations representing all type of industries, small and large. These are 'Federation of Indian Chambers of Commerce and Industries' (FICCI), Confederation of Indian Industries (CH) and 'Association of Chambers of Commerce and Industries' (ASSOCHAM). These associations represent mainly the interests of large scale industries.

However, these associations have membership of small sector as well and represent mainly the policy related interests of SSI sector.

The exclusively small industry related associations are diversified geographically and sectorally and are supposed to have been linked with 'Federation of All India Small Scale Industries' (FASSI), 'Federation of Small and Medium Industries' (FOSMI) and also Indian Council of Small Industries (ICSI). However these institutions are weak in character due to their working, for cross purposes and lack of dynamic perspective for small scale sector growth. They have virtually no linkages with the small industry in general and their local associations in specific. Another institution that is concerned with the small and medium enterprises is 'World Assembly of Small and Medium Enterprises'(WASME). There are only a few of the local associations that are involved in providing specific individual level services to the small industry. However, the associations are involved in lobbying with the government to provide one or the other facilities or benefits to the sector.

APPENDIX C: Methodology Used to Identify Energy Intensive Sub-sectors

Nature of Central Statistical Organisation (CSO) Survey Analysis

The following sampling design applies to the CSO data for industrial groups at the 3 digit level. The strata or industrial groups were divided into three categories for the purpose of sampling as follows:

Category 1: Those industry groups where the number of factories is 20 or less.
Category 2: Those industry groups where the number of units, within each group is between 21 and 60.
Category 3: Those industry groups where the number of units, within each group is 61 or more.

All the factories in each group of category 1 were completely enumerated. A fixed sample of 20 units from each group belonging to category 2 was drawn while a sampling of one in three was adopted from each group of category 3.

There were implications from this sampling design that were not fully appreciated until more information was supplied from the CSO relating to data from the Industrial Census. The Industrial Census data covers all industries with over 100 employees and all of these are included in the CSO survey data before the above sampling design is applied. The actual numbers of units in each industrial category were provided separately and are at a 4 digit category level. The way this information was dealt with and the implication of it are considered below. An extract of the table providing this information provided is shown in Table A4.4.

Methodology

The overall approach to analysis is determined by the objective of this research, i.e., to identify high energy using and polluting industrial activities, employing a large number of low income workers in small and medium sized units, so that interventions would generate more benefits for the employed poor and the neighbourhood.

In relation to the CSO data, it was considered that categories to whom the following attributes applied should be drawn out:

- high fuel and electricity usage (therefore with potential for significant energy efficiency impact and possible environmental impact);
- large total numbers of employees (more people involved overall in consequential benefits of any energy efficiency improvement);
- predominance of smaller-scale units (likely to employ higher proportion of poorer paid workers);
- high net value added per employee (likely to be more amenable to implementing energy efficiency measures);
- high productive capital investment per employees (as evidence of investment capability)

Step 1:

Given that the data available are at three levels of aggregation, there were two options. These were (i) whether to move from the highest level of aggregation, through a process of selection, to the activity carried out in the factories; or (ii) to start from the factory level (4-digit categories) and through a process of selection, move up to the two digit category. Given the aim of the study the first option was considered more appropriate and therefore initial analysis was applied using the above criteria at the two digit category level. However when this approach was applied anomalous groups were evident which appeared to meet these criteria but when looked at with more resolution, at the 3- digit level, the criteria did not apply. Following consultation with the CSO, the decision was made to focus analysis at the 3-digit level.

Step 2:

Before proceeding with more in-depth analysis at the 3-digit level it was observed that certain of the 3 digit categories representing large scale units and higher level technology were really outside the scope of this study, particularly in relation to poverty issues. Also some of these categories are already being targeted by other DFID programmes. As they were likely to dominate the type of criteria that were being considered i.e., fuel use, investment levels, added-value etc., a number of categories were extracted prior to subsequent analysis. This reduced the total categories examined from 199 to 157. This step in the analysis will need to be re-examined at a later stage to try and define an objective basis for the cut-off that has been applied.

Step 3

In order to extrapolate representative data at the 3 -digit group level from the CSO survey for all the industrial groups it was necessary to follow the procedure below:

(i) take the census data at 4-digit level and aggregate it according to the 3-digit categories

(ii) deduct the number of census returns calculated for the 3-digit category in (i) above from the CSO survey totals at the 3 digit category group level

(iii) multiply the number derived above at (ii) by 3

(iv) add the numbers derived at (i) and (iii) above. This then provides the total number of units for all India in each 3 digit industrial category.

The above method is the only approach that could be adopted in the absence of complete Industrial Census data of the same form as available in the CSO survey data. This approach is recognised to introduce a level of distortion with a bias in average data weighted towards larger scale factories as these are included to a greater degree than smaller factories.

Step 4 *Ranking and Selection*

To be able to proceed with the selection process at the 3-digit category level, the next activity was to establish criteria to be used. This was then followed by a ranking of categories according to these different criterion. Finally it was necessary to decide an algorithm and make a selection based upon these criteria. This process is described below.

The following parameters were calculated from the CSO survey data but based upon the total number of units derived as described after incorporation of the Industrial Census data

1. Fuel cost (billion Rs) per category
2. Electricity consumed (billion KWH) per category
3. Number of employees (thousands) per category
4. Value added per employee for each category
5. Productive capital investment per employee for each category
6. Average number of employees per factory for each category
7. Ratio of number of census to non-census factories for each category

The last two parameters provide an indication of the predominance of smaller units in a given category.

Once these parameters had been generated they were ranked in decreasing order. Then in order to short-list and select the categories that would be attractive for energy efficiency measures, criteria were set for each parameter as follows:

1. Falling in the first half of fuel cost
2. Falling in the first half of electricity consumed
3. Falling in the first half of number of employees
4. Falling in the first half of value added per employee
5. Falling in the first half of productive capital investment per employee
6. Falling in the lower half of average number of employees per factory
7. Falling in the lower half of ratio of number of census to non-census factories

The condition made for an industrial category to then be short-listed was that it must meet at least 6 of the above 7 criteria. This then resulted in a short-list of 18 factory categories as given in Table A4.5 where the selection process is detailed.

Step 5 *Short-listed categories.*

The description of short-listed industrial activities is given in Tables 4.2 to 4.4. Though this study is primarily concerned with combustion related pollution, it interesting to note their overall potency for environmental damage. The Central Pollution Control Board has categorised industries into Green, Orange and Red in order of increasing potency for environmental damage.

Showing industrial categories which satisfied all 7 criteria

Manufacture of vegetable oils
Preparation of raw wool, silk and artificial fibres
Knitting and crochet
Manufacture of paints, varnishes etc.
Manufacture of chemical products not classified elsewhere
Manufacture of plastic products
Manufacture of structural metal products
Manufacture of special purpose machinery
Manufacture of Electric fans
Manufacture of vegetable oils
Preparation of raw wool, silk and artificial fibres

Manufacture of paints, varnishes etc. Manufacture of chemical products not classified elsewhere Manufacture of plastic products Manufacture of structural metal products Manufacture of special purpose machinery Manufacture of Electric fans

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