DFID Project R7413:
Mechanisms to Improve Energy Efficiency in Small Industries

Part One: Poverty and Energy Efficiency in Small Industries – A Review of the Issues

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PART 1 : POVERTY AND ENERGY

PREFACE

The main objectives of the DFID Project R7413 are to promote mechanisms to increase the adoption of energy efficient technologies and practices in the case of one small scale industry sector in India and Ghana. The sector chosen in India is the ceramic sector. The focus of the work has been in one large cluster of ceramic firms in Khurja, India. In Ghana the sawmill sector was studied. The process followed in the project has been to:

- map the operational practices in a sample of units and develop working relationships with relevant stakeholders;
- examine existing practices to determine possible improved practices that could be adopted including new technologies in the main energy using parts of the operations, and,
- analyse the extent to which energy efficiency gains can be achieved in a manner that is also financially attractive to the firms.

Finally, the intention of the project is to examine the barriers to the adoption of improved technologies and to suggest specific interventions to reduce the barriers. This is provided that the suggested improvements are found to have a sufficiently high rate of financial return, making them potentially sustainable without subsidies.

This section first sets out to review the possible links between energy efficiency improvements and poverty reduction. The purpose of the first section is to review the issues that could have an impact on poverty reduction in this project that explores the gaps between existing practices of small industry with respect to their use of energy and to explore the potential for improving their energy use.

The original project proposal did not attempt to deal with issues of poverty as the project had a set of objectives that were valid and coherent on their own terms. When the proposal was approved by DFID, the requirement to explore the possible links of energy efficiency with poverty removal was added to the project. An exploration of the links of poverty with energy and with energy efficiency are reviewed in this first section.

The work done in India is detailed in the following sections:

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BRINGING BENEFITS TO THE POOR

DFID: Energy and Poverty

Improving the energy efficiency of end users has been one of the three main areas of the ODA's (now DFID) energy strategy. The rationale for this came from the Rio conference in 1992 where the Framework Convention on Climate Change (FCCC) and Agenda 21 were launched. The objectives of the ODA's energy strategy were thus to:

- Conserve fossil fuel resources;
- Improve the economics of energy production and use;
- Alleviate environmental damage by minimising the production of harmful emissions.

The transformation of the ODA into DFID has brought a renewed focus upon poverty elimination through a commitment to the International Development Goals. One of the Development Goals concerns the protection and better management of the environment. As one of the indicators for this goal is CO_2 emissions per unit of GDP, improving end-use energy efficiency remains relevant to DFID's objectives.

However, according to DFID "*the overriding poverty focus of DFID's work requires that any future interventions can be justified also in terms of positive impacts on poverty. While intuitively it can be said that energy efficiency is a 'good thing' a positive correlation with poverty reduction is yet to be shown. Hence there is a need for greater knowledge in this area."*

So DFID is "expecting this project to demonstrate that improving industrial energy efficiency is worthy of DFID, private sector and beneficiary government activity, in terms of bringing positive benefits to the poor. If such benefits can be shown, these actors can then design larger scale interventions in the future with confidence."

This expectation of DFID can be met in several ways; one of these is through a review of the literature and the theoretical issues connecting energy efficiency, small-scale industry and poverty. Hence, this overview paper provides a broad discussion of knowledge and experience in this area.

Another way that the expectations of DFID can be met would be through the results of this KAR project. We will argue that while there are many strong and positive linkages between the issues, any expectation that this project as conceived and designed will by itself serve to fully demonstrate these linkages is not likely. This conclusion is drawn from several factors. First, the project as designed, and with the resources available, will be fully stretched to simply undertake the tasks of analysing the barriers to energy efficiency in the sectors, examining the opportunities for their improvement and developing strategies for sustainable support to the small industries in undertaking these improvements. In fact as we see in the conclusions, the project resources were woefully

constrained to fully achieve the above objectives. As many of these results will occur over time, and any larger impacts will be outside the project time frame, to observe the follow on direct and indirect impacts from the project specific activities is highly unlikely. There are alternative research designs that can focus on the poverty and energy efficiency linkages directly by using a sample of units to compare where such changes have already taken place, and their impacts, with a matched sample of units where such changes have not taken place. But this requires a very different research design and the two different designs cannot be combined. We provide a section describing a parallel effort that will be made to explore the poverty linkages in a fairly rudimentary and tentative fashion.

Developing a Framework

The project aim is to explore approaches to promote energy efficiency in two small and medium industry sectors in India and Ghana. In order to make the appropriate linkages in our discussion between energy efficiency and poverty, we will address several issues. First, we have to establish the meaning and operational definitions of poverty. Then we will explore the causal factors that have an impact on poverty status, alternate development paths and measures that reduce poverty. Separately, we have to examine the role of energy in any development path which may be adopted and determine whether energy is a principal factor which can promote the desired path, and, whether there are preferred and less preferred energy options for the development strategy. We can then determine whether and in which ways any improvement in energy efficiency in economic sectors contributes or can contribute to a reduction in poverty. Once the links between poverty, appropriate development strategies and energy and its efficient use are established, we still need to examine whether the focus on small and medium enterprises is a valid one. So we need to review the specific advantages and disadvantages of SMMEs and their economic performance within a poverty reduction development path.

If we do find a causal link between the several different concepts, there are several new issues that will need to be explored. One is the extent to which this particular project can contribute to poverty reduction and how that can be measured. Another issue is, if there are several alternative ways to achieve the same energy efficiency goals, or if the selection of an alternate sample of beneficiary groups creates a differential impact on poverty, then which strategy should be preferred. This question of strategy can be addressed at a larger level with regard to the overall policy of DFID and it can also be addressed at a more micro level with regard to the project boundaries and sub objectives. It will become clear that the answers at the larger program level can well be different than at the project level.

Given the extensive range of issues to be covered this cannot be a very detailed review within the current project. But we have attempted to cover all the main issues raised. This review then argues that improving industrial energy efficiency does bring positive benefits to the poor and is worthy of DFID support. We also suggest that even after this conclusion there are a range of options for further focus by both DFID for its over all

program and for this individual project. We recommend that the focus of DFID needs to cover many of the broader issues that can have larger, albeit indirect poverty reduction impacts, rather than be limited only to direct impacts on the poor from each and every project. But obviously any final decision remains that of DFID.

What is Poverty?

To see how improving industrial energy efficiency brings benefits to the poor, we must first define what poverty is. A general and dictionary definition of poverty is "The state of one who lacks a usual or socially acceptable amount of money or material possessions." (Merriam-Webster's Collegiate Dictionary, 1995).

This definition already begins to suggest that the meaning could be seen in terms of absolute levels of material possessions or relative levels. It also suggests that there is a dynamic aspect of poverty, and that the concept of poverty varies from time to time and from society to society. What is "socially acceptable" in India is quite different from that in the U.S.A., furthermore, as a country's economic landscape changes, views about the "minimum necessaries" evolve (Kanbur and Squire, 1999). Finally, within a given definition there is also another dynamic element in that an individual or group may over time move into or out of poverty.

Let us explore each one of these ideas in a little more detail.

The most basic definition of poverty in its classical form is the absence of basic incomes necessary to acquire the minimum calorific inputs required to sustain life. This was the approach used by Rowntree (1910) in his study of the city of York, England. The Indian poverty line uses the same basic approach defining a basket of goods considered to be the minimum necessary to sustain life (the same approach is also taken in the USA). This definition arrives at a minimum daily income level of Rupees 49 in rural areas and Rupees 57 in urban areas (at 1973 – 1974 prices adjusted for the cost of living with respect to the rural and urban price index respectively). By this definition approximately 35% of the Indian population lives below the poverty line and are thus defined to be poor. The use of poverty lines is common to measure poverty world-wide and to observe changes over time (Kanbur and Squire, 1999).

This concept is also applied to the widely known measure of poverty introduced by the World Bank in the 1990 World Development Report. This defined the poor as those whose per capita expenditure was below US$1 per day (expressed in 1985 PPP dollars, it refers to per capita household expenditure converted by the purchasing power parity for different regions). By this definition, the proportion of the poor in India increases from the Government-defined level by another 10 – 12%.

The concept of a US$1/day poverty line appears to be a simple and convenient benchmark to define poverty. But such a definitional simplicity obscures many untidy issues. First, any definition of poverty changes over time and as societies grow richer, the definition of the minimum basket of goods changes with it and becomes larger. For instance, the US poverty line is ten to twenty times higher than that of India (in PPP

terms) and has increased approximately 0.75% for each 1% increase in real disposable income (Fisher, 1996). Other criticisms of this simple approach are that it does not distinguish between transient and chronic poverty, does not value non-market goods and services for local variations (Ravallion and van de Walle, 1991) and many other issues (See Kanbur and Squire, p. 4).

Once a definition is agreed upon measures must be devised to quantify poverty levels. Even with this relatively simple approach poverty measurements are plagued not only by the definitional issues that we have discussed earlier but also by measurement issues. In many countries, the development of a reliable national database on the incidence of poverty is lacking. India is considered to have a relatively sophisticated national statistical system and has collected data on the incidence of poverty for several decades.

But even in India, there are several major problems with the data. First, it has been argued that the cut off level used for the measurement of poverty is set too low and so it underestimates the amount and incidence of poverty. Economists specialising on measurement issues disagree on the percentage of the very poor, even when they use the same official benchmark for defining poverty levels, by the order of magnitude of one hundred percent.

Second, it is argued that the poverty line needs to be adjusted more carefully than is the usual practice to take into account different prices across the country and the differences in the consumption basket of the poor in rural and urban areas, between market and non-market goods and services. It is almost impossible to review here the many possible variations that have been proposed and their implications for the measurement of poverty levels. (See Lipton and Ravallion, 1995, for a survey of these issues.)

While Lipton and Ravaillon conclude that the measure of consumption levels is the preferred indicator of poverty, an alternative approach treats income (or expenditures) as a tool towards more fundamental goals. For instance, the 1980 World Development Report describes poverty as a condition characterised by malnutrition, illiteracy and disease. This is in keeping with the definition of Sen that poverty is an absence of certain ‘capabilities’, required to function effectively as a human being and these include better education, health care and so on. In the formulation by Sen ‘capability’ improvement leads to higher incomes but higher incomes do not necessarily lead to higher capability (Sen, 1981). This in turn has led to the development of the Human Poverty Index by the UNDP.

The World Bank also acknowledges the importance of other dimensions in terms of defining poverty. They cite access to health services, education and power or decision-making, as well as levels of income, consumption and exposure to risk as issues affecting the poor. A reasonable and practical approach to the multiple dimensions of poverty is a hierarchical matrix developed in the Philippines (ADB, 1999). This starts with the premise that the highest need is survival. The survival need requires a basic minimum of food / nutrition, health, water / sanitation and clothing. The second level is security. Here the needs are defined as shelter, absence of violence, security of income

(a dynamic and not static concept), and employment. The third level includes 'enabling' conditions and these include education, skills, participation, family network and psycho-social needs. For these three hierarchical levels, a total of 33 indicators have been developed.

It is obvious as one improves the definition of poverty from the simplest basic needs approach, that the issues of measurement multiply.

Finally, we must mention one other relevant dimension of poverty. Many argue that poverty cannot be measured simply by the presence or absence of 'adequate' levels of consumption and certain goods and services, however defined, but that it is a relative concept. It should be analysed by the distributional effects within a given society and also between societies. This implies that in a richer society, the levels of poverty should be set higher. The corollary is that as a country or economy grows, the 'poverty line' should rise with it. Ultimately, this definition if used very strictly, will deny that there is any reduction in poverty, no matter how large the economic growth is, unless increased equity and distributional effects accompany the economic growth. Unfortunately, the data from country level studies, over several decades and comprising of over 50 countries shows that distributional changes are rare and much more difficult to achieve. The distribution of economic outputs in a society appears to be dominated by more persistent social and institutional factors, which are extremely resistant to change.

Taking a consensus of the views expressed in the documents and from a number of country dialogues of the ADB, we may conclude that some basic indicators of poverty are inadequate levels of:

Table 1.0

1. Food	9. Employment
2. Nutrition	10. Education
3. Health	11. Skills
4. Water / Sanitation	12. Participation
5. Clothing	13. Family
6. Shelter	14. Psycho-social Needs
7. Security	15. Equity and Distribution
8. Income	

We will use these 15 indicators later to see where and how energy interventions improve the availability of the above. However (as has been noted before), there is an inherent subjectivity and social specificity to any notion of "basic needs", including nutritional

requirements. For example, psychologists, sociologists and others have argued that the circumstances of the individual relative to others in some reference group influence perceptions of well-being at any given level of individual command over commodities. By this view, "the dividing line ...between necessities and luxuries turns out to be not objective and immutable, but socially determined and ever changing" (Scitovsky, 1978, p.108). Some have taken this view so far as to abandon any attempt to rigorously quantify "poverty". Poverty analysis (particularly, but not only, for developing countries) has become polarised between the "objective-quantitative" schools and "subjective-qualitative" schools, with rather little effort at cross-fertilisation. We conclude this overview of poverty by stating that we will avoid here the debates between the objective and subjective schools, and also avoid excessive discussions on whether the above or additional parameters capture poverty adequately. Such discussion will take us too far from our main objectives, but we only note here that many studies show that the use of different indicators does not change greatly who the poor are and again, in many cases, these indicators tend to move together.

Strategies and Approaches Towards Poverty Reduction

If we limit our definition of poverty to that of a lack of income or capacity to acquire a minimum basket of goods and services, then clearly economic growth and redistribution of incomes towards increased equality become the two principal mechanisms for the redress of poverty. They can be followed independently (provided the chosen economic growth strategies do not worsen income distribution) or simultaneously. There has been considerable debate on the value of each of the above strategies and the extent to which there are tradeoffs – that is whether growth-promoting strategies worsen distribution and whether distributive strategies reduce growth rates. There are also finer issues, first suggested by Kuznets, that growth promoting strategies may always worsen distribution for an initial period, and then when incomes cross a thresh hold, distribution improves again.

At this time the consensus of economists, policy makers, and the international development support community is that economic growth is necessary for poverty reduction, but most likely is not a sufficient condition to reduce poverty. Further, higher rates of economic growth reduce by larger numbers the poor and also improve living standards of the poor by higher amounts. This view, which had been strong in the 50s and 60s, has re-emerged as a high priority from new evidence from several studies and experiences.

Economic growth has a positive effect on employment and poverty reduction. Overall, the poor gain from broad-based economic growth (Kanbur and Squire, 1999) and on average, absolute poverty falls with economic growth (Fields 1989; World Bank 1990; Squire 1993; Ravallion 1995; Lipton and Ravallion 1995; Bruno et al. 1995). In fact, absolute poverty is positively related and very sensitive to economic growth and its benefits are definitely not restricted to those near the poverty line (Bruno et al. 1995).

But what causes economic development? Hogendorn (1992) summarises in very general terms the five different factors which influence economic development: (1) increasing savings, investment and technology adoption, (2) agricultural improvement, (3) increasing international trade with a focus on comparative advantage, (4) improving economic efficiency (of the system and its agents), (5) human capital formation.

Of course economic development and growth is not the result of any single one of the above factors, but rather a complex amalgam of economic and social determinants. These include, among others, initial endowment, availability of capital (physical, natural and human), technical improvements, cultural and institutional differences, etc.

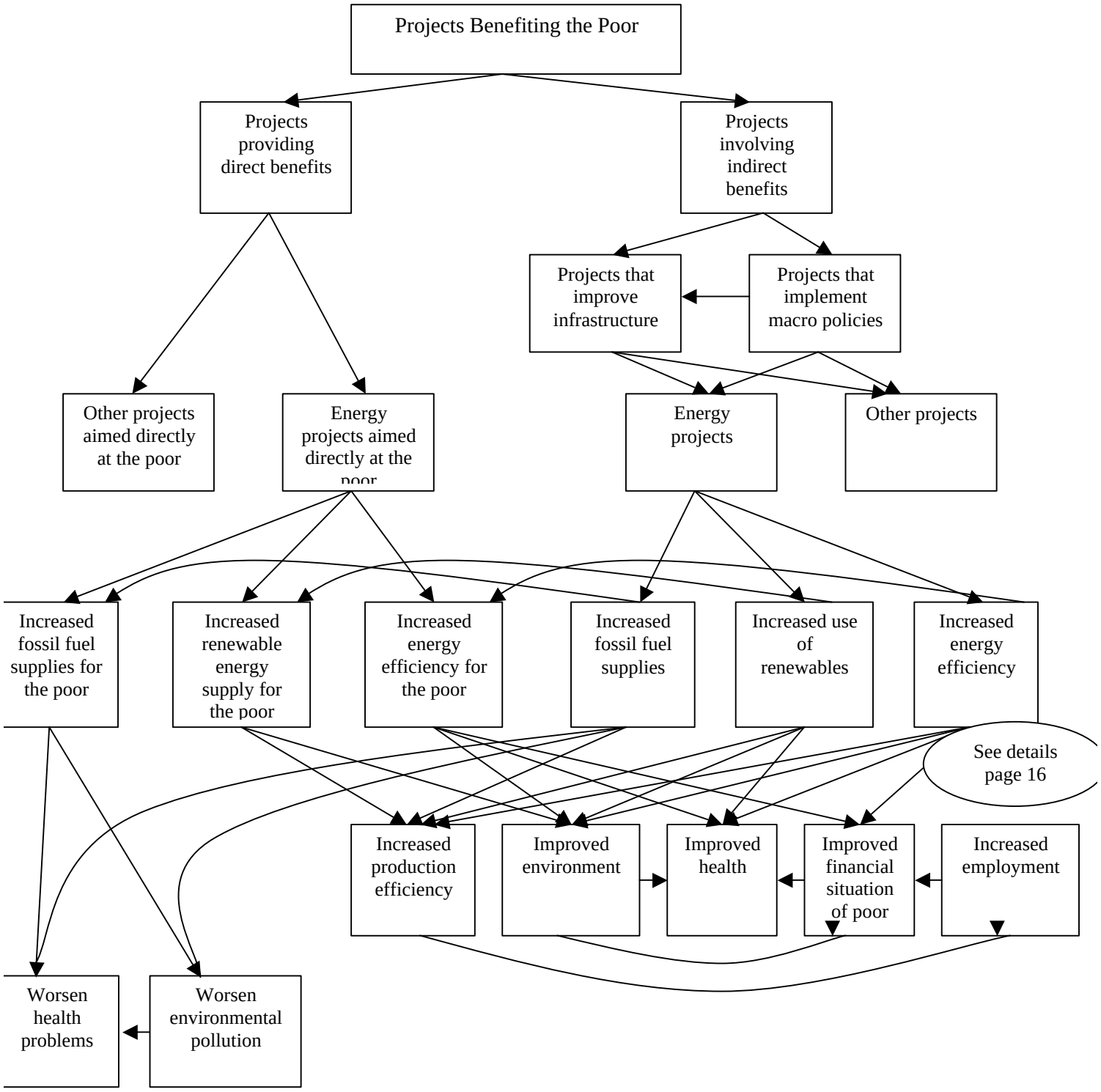
The most dramatic evidence of the largest poverty removal effects has been observed in the East Asian countries. In 1975, approximately sixty percent of the population lived below the poverty line and after twenty years of high rates of growth, ranging from 6 – 12% annually, reduced the numbers of absolutely poor to twenty percent. Again in the same region, the recent financial crisis brought about large contractions in the economic output, resulting in a reversal and large increase in the number below the poverty line. Similarly, poverty in India has declined from a range of between 50 and 65 percent in the mid-1960s, to about one-third of the population by the early 1990s. This steady decline in poverty was strongly associated with agricultural growth. Public investment in rural areas benefited the poor through its impact on the growth of the rural non-farm economy. And, government expenditure on rural poverty and employment programs, which has grown rapidly, has directly benefited the rural poor (Fan et.al. 1998). As the noted Indian economist Pranab Bardhan states " In the areas where growth has been the strongest poverty has fallen the most. The problem is that by itself (growth) is not enough" (IFPRI, 200 In Brief, September 1999).

But as with the definition of poverty and its measurement, where there are many disagreements, there are also many disagreements on the most approximate strategies that promote poverty removal and not everyone agrees with the primary importance accorded to growth. A large mainstream view would suggest that not all growth is equally desirable. The new paradigm is encapsulated in the Agenda 21 and its call for sustainable development. Even here, while growth is given the highest priority for poor countries, a distinction is made that the growth strategies must be sustainable in the longer term future and this requires simultaneous consideration of environmental and equity dimensions.

The earlier concern of tradeoffs between growth and equity has give way to a general agreement *that paths that promote growth together with equity and a concern for environmental assets and constraints are available and provide the best course for long-term development* (Munnasinghe, 1999). Thus, investments and policies that complement each other and promote all dimensions at the same time, or at least do not worsen one dimension while promoting another, are to be favoured. Many of these recommended policies are broad in their application and do not specifically target the poor. These include policies that promote macro-economic stability, increase in overall productivity, infrastructure such as roads and communications, good governance and

expansion of education and they can have large impacts on all dimensions of poverty. But it is very difficult, often impossible, to isolate the cause and effect relationship between these broader actions and their direct impact on poverty. These broader policies and actions must ultimately rest on theoretical understanding of development processes and desired social goals.

The diagram below illustrates the types of projects available that can benefit the poor, from those targeted at direct poverty removal to those providing more indirect benefits. Energy projects are also detailed; the interactions between energy and poverty are complex and often indirect, however, the impact of the former on the latter is in general positive.


Projects Benefiting the Poor
Projects providing direct benefits
Projects involving indirect benefits
Projects that improve infrastructure
Projects that implement macro policies
Other projects aimed directly at the poor
Energy projects aimed directly at the poor
Energy projects
Other projects
Increased fossil fuel supplies for the poor
Increased renewable energy supply for the poor
Increased energy efficiency for the poor
Increased fossil fuel supplies
Increased use of renewables
Increased energy efficiency
See details page 16
Increased production efficiency
Improved environment
Improved health
Improved financial situation of poor
Increased employment
Worsen health problems
Worsen environmental pollution

The World Bank's World Development Report 2000/01, largely supported by the development community and many national governments, proposes to attack poverty on three fronts: by empowering the poor and increasing their participation in decision-making; by providing the poor with security against economic shocks; and finally, by creating opportunities for the poor through the establishment of conditions propitious to sustainable economic growth. Giving priority to education, health and nutrition directly improves the well-being of those living in poverty, in addition to increasing the chances of improving income distributions and average income (Bruno et al. 1995).

Most government policies and donor programs attempt to support the broader actions above while at the same time directing some of their efforts at targeted program for poverty removal. Targeted poverty reduction programs are common in India and many other countries. These aim to provide income generating opportunities for the poor through public works and rural enterprises (as in China,), and provide assets such as finance and livestock. In India, special measures are in effect to promote micro and small enterprises, which provide opportunities for off-farm employment. Other measures include strengthening organisations of the poor, providing protection against risks, increased access to education and health care, and so on. Some of the programs directed to provide direct benefits to people living in poverty, suffer from poor targeting, leakage of funds and poor choice of investments.

Martin Ravallion argues that in India poverty fell the fastest in Punjab and Haryana due to fast growth; the alternate strategy of human development through education was stressed in Kerala but its economy did not grow fast enough to provide employment. There the educated workforce migrated abroad and their remittances contributed to poverty reduction. From this he argues that the ideal strategy is a combination of economic growth and human resource development. In the earlier Indian experience much of the poor were in rural areas and the growth which contributed to the reduction of poverty was agricultural growth promoted through increased irrigation, higher inputs of energy, new seeds, fertilisers, extension services and roads. But most experts agree that the easier gains in agriculture have been achieved, and further poverty removal efforts require the growth of employment in the non agricultural sector (Kirit Parikh, in IFPRI 2010). We will see in the next section that increased energy supplies have been important in both India and Ghana in promoting growth and their shortages have also been a major constraint on both growth and poverty reduction. We will also see that small and medium enterprises have been a critical element of the strategy to provide new employment opportunities.

A Case of Indirect Inputs Contribution to Poverty Removal

One study investigates the causes of the decline in rural poverty in India, and particularly to disentangle the specific role that government investments have played, and the effectiveness of different types of government expenditures in contributing to poverty alleviation. The study uses state level data for 1970 to 1993 to estimate an econometric model that permits calculation of the number of poor people raised above the poverty line for each additional million rupees spent on different expenditure items. The model is also structured to enable identification of the different channels through which different types of government expenditures impact on the poor and it distinguishes between direct and indirect effects. The direct effects arise in the form of benefits the poor receive from employment programs directly targeted to rural poor. The indirect effects arise when government investments in rural infrastructure, agricultural research, health and education of rural people, stimulate both agricultural and nonagricultural growth, leading to greater employment and income earning opportunities for the poor, and to cheaper food.

But targeting government expenditures simply to reduce poverty is not sufficient. Government expenditures also need to stimulate economic growth. This is needed to help generate the resources needed for future government expenditures. It is also the only way of providing a permanent solution to the poverty problem, as well as to increase the overall welfare of people.

The model is therefore formulated so as to measure the growth as well as the poverty impact of different items of government expenditure. This enables us not only to rank different types of investment in terms of their growth and poverty impacts, but also to quantify any tradeoffs or complementarities that may arise between the achievement of these two goals. The results from our model show that government spending on productivity enhancing investments, such as agricultural R&D and irrigation, rural infrastructure (including roads and electricity), and rural development targeted directly on the rural poor, have all contributed to reductions in rural poverty, and most have also contributed to growth in agricultural productivity. But differences in their poverty and productivity effects are large.

Additional government expenditure on roads is found to have the largest impact on poverty reduction as well as a significant impact on productivity growth. Additional government spending on agricultural research and extension has the largest impact on agricultural productivity growth, and it

also leads to large benefits for the rural poor. It is another dominant "win-win" strategy. Additional government spending on education has the third largest impact on rural poverty reduction, largely as a result of the increases in non-farm employment and rural wages that it induces. Additional irrigation investment has only a modest impact on growth in agricultural productivity and an even smaller impact on rural poverty reduction, even after trickle down benefits have been allowed for. Additional government spending on rural and community development, including Integrated Rural Development Programs (IRDP), contributes to reductions in rural poverty, but its impact is smaller than expenditures on roads, agricultural R&D, and education. Additional government expenditures on soil and water conservation and health have no impact on productivity growth, and their poverty effects through employment generation and wage increase are also small.

The results of this study have very important policy implications regarding directions of preferred investments and the larger benefits that often accrue indirectly than direct poverty reduction expenditures. additional government spending on rural development is an effective way of helping the poor in the short-term, but since it has little impact on agricultural productivity, then it contributes little to long-term solutions to the poverty problem.

Energy and Poverty

There are strong direct and indirect linkages between energy and poverty. The direct linkages come from the fact that everyone, poor and non poor, needs a certain minimum energy for basic survival. Energy is required for cooking and often for drinking water, irrigation, health care, and often for sanitation, education and employment. So a minimum input of energy is required by the poor, who often lack the minimum provisions of energy. In many cases the poor pay excessively for the energy that they use in either time or cost or both; this cost is typically borne by women and children (Lamech et al 2000 p.2). In many cases, poverty forces the poor to use energy with poor efficiency as in the case of wood stoves for cooking or in many traditional production activities. This often forces the poor to cause and suffer greater environmental harm. Thus improvements in energy supply directed at the poor increase their well being by reducing the costs or increasing opportunities.

Beyond these direct effects, energy is a specially important input for economic growth. A simple correlation between per capita energy consumption and per capita incomes in different countries and over time shows that low energy consumption is associated with poverty. This is because additional energy inputs remain a key supplement to human energy in order to increase outputs per person. Demand for energy rises roughly in step with economic growth (Lamech et al 2000 p.3).

The correlation between energy use and economic growth is further evidenced by the counterfactual when its shortage constrains economic growth (Lamech et al 2000 p.6). In both India and Ghana, suffering from energy shortages ranging from 20 – 30%, the loss of production and employment, and consequent impact on poverty is very large. It is estimated that power curtailment to the Ghanaian industrial sector as a result of a power crisis in 1998 was responsible for losses of US$500 million (Rath mimeo 2000). In India, the shortage of energy is estimated to cost an additional 30 million dollars annually in steel production alone. In many states, industry and farms are only able to get power supply on alternate days. Some restrict their production and employment accordingly and others resort to higher cost and more polluting stand by generators. The investment in on-site energy generation in India and other countries such as Uganda and Indonesia also "significantly reduces the productive investment of firms," (Lamech et al 2000 p.6).

There was a time when energy was considered a central part of the process of economic and social development (Barnett, 2000). Barnett goes on to say that:

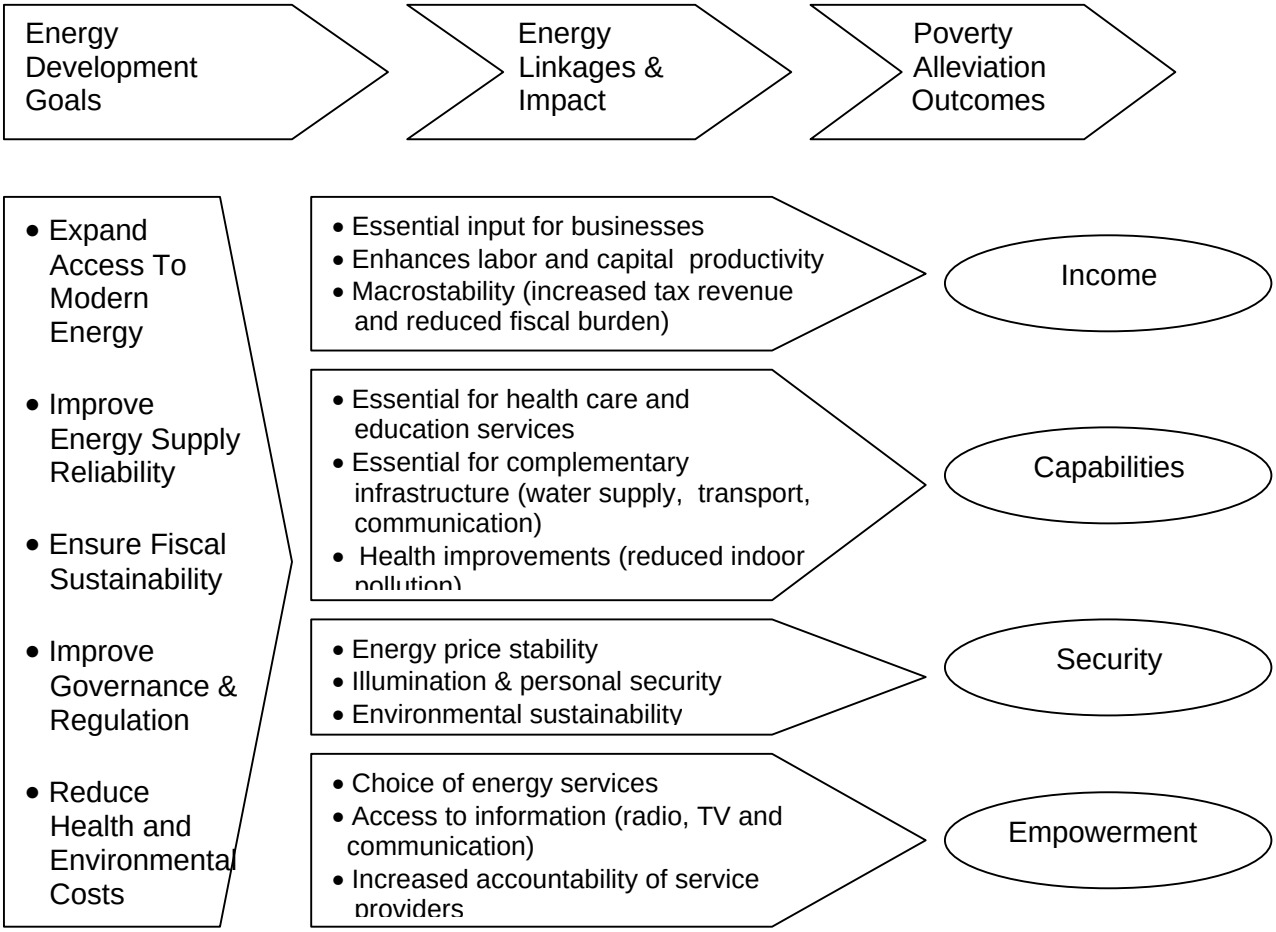
> "If we look at developing thinking today, 'energy' appears to have fallen off the agenda as an important factor in the development process (though as we shall see energy is seen in largely negative terms in the current environmental debates). A glance at some of Britain's leading development research institutions, such as the Institute of Development Studies and the Overseas Development Institute shows that they do no work on any aspect of energy and development. Similarly the first draft of the World Bank's recent World Development Report on poverty has no mention of energy. Despite publishing a large amount of material on energy and development, and undertaking significant research on energy and poverty, this does not appear to be reflected in the core of the World Bank's business.
>
> The UK's Department for International Development is developing a new "Livelihood Approach" to development, but it contains no mention of energy, and their new "Target Strategy Papers" contain only passing references to energy. A quick examination of the web pages of the Institute of Social Studies suggests that energy is not regarded as important to their view of development either" (Barnett, page 3).

We will not review here the many strong arguments made by Barnett to show very strong association between energy use and availability in the economy and production, growth rates and a positive Human Development Index. Unfortunately, for simple minded programming, the argument that increased energy availability will reduce poverty cannot be made. While at the same time, all the evidence cited by Barnett and Lamech below, suggest that reduction in poverty levels will require increased levels of energy supply than is available today in India or Ghana.

The World Bank's *Poverty Reduction Strategy Sourcebook* outlines the framework in the diagram below to illustrate the energy sector's poverty alleviation impacts. The energy

sector was formerly narrowly conceived as simply providing an essential input to economic development (Lamech et al 2000 p.3). However, more recently the energy sector's role has expanded to "cross-sectoral interventions that combine delivery of a range of infrastructure and social services" (Lamech et al 2000 p.3).

The Energy Poverty Framework



Source: World Bank Poverty Reduction Strategy Sourcebook, Energy Chapter

The approach outlined in the diagram however is distinct from this project as it (the former) is concerned with the direct provision of energy services to the poor, rather than energy efficiency.

Apart from the energy sector's link to poverty, similar links also operate with other basic infrastructural inputs such as transport, communications and others. Each one of them can have a targeted and direct impact on the poor, to the extent that they utilise these services, but in all these cases the indirect effect is much larger and yet more difficult to establish.

Though we have argued that adequate supplies of energy, which in our two countries also improve larger qualities of energy supply, are growth promoting and their shortage is a critical barrier to poverty removal, it does not immediately follow that all actions to promote energy supplies will lead to positive developmental outcomes.

This is because it is not the energy itself which we value but the uses that stem from the availability of energy. Given that energy supplies carry with them additional environmental costs, clearly alternatives which increase the efficiency of energy use to augmenting energy supplies are to be preferred, if both options provide similar economic rates of return. Hence, economically attractive energy efficiency opportunities provide larger contributions to economic growth and thus to poverty removal than increases in energy supply.

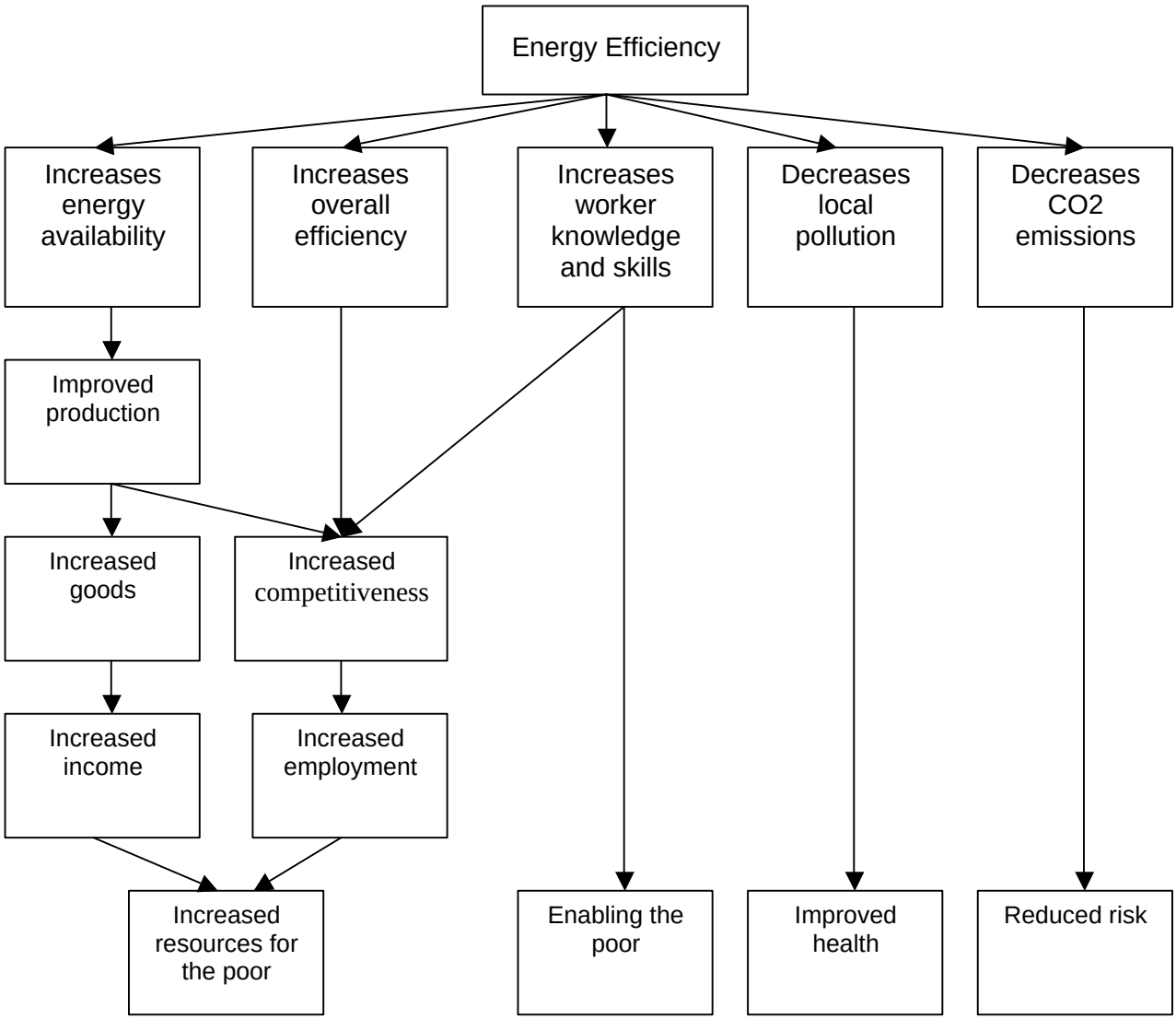
The table below brings together various points of the above discussions. It indicates the impact of increasing energy inputs for the poor and in the economy at large, and of improving energy efficiency, for the poor and in the productive sector, for the fifteen indicators of poverty identified earlier. This is followed by a diagram detailing specifically how improvements in industrial energy efficiency can bring benefits to the poor.

Table 1.1

	Indicators	***Increasing Energy Inputs***		***Improving Energy Efficiency***	
		For the Poor	***In the Economy***	***In uses by the poor***	***In the Productive Sector***
1	***Food***	Improves	Improves	Improves	Improves
2	***Nutrition***	Improves	Improves	Improves	Improves
3	***Health*** *(coal&pollution)*	Worsens	Worsens	Improves	Improves
4	***Water / sanitation***	-	Improves	Improves	Improves
5	***Clothing***	-	Improves	-	Improves
6	***Shelter***	-	Improves	-	Improves
7	***Security***	Environmental security worsens	Environmental security worsens, job security improves	Environmental security improves	Environmental and job security improves
8	***Income***	-	Improves	-	Improves
9	***Employment***	-	Improves	-	Improves
10	***Education***	-		-	Improves
11	***Skills***	-	-	-	Improves
12	***Participation***	-	-	-	Improves
13	***Family***	-	-	-	-
14	***Psycho-social needs***	-	-	-	-
15	***Equity & distribution***	-	Tends to improve/ Associated with improvements	-	Possible

Energy Efficiency and Links to Poverty

The chart below provides a conceptual framework of the linkages between energy efficiency and poverty reduction. The indicators and linkages are discussed in the context of small enterprises subsequently.



Consumption/income

Energy efficiency improvements generate savings and improvements in the production process through lower energy costs, reduction of waste, increased productivity etc. By reducing resource use, energy efficiency improvements will increase the industry's overall efficiency. This increased efficiency will inevitably lead to increased profits. These higher profits can benefit the poor in various ways:

1. If the enterprise is of the micro size, then the workers and owners of the enterprise are often the same. Thus reduced costs translate immediately into increased earnings by the poor potter families.

2. Where the units use hired labour there the chain of effects become more indirect. Profits can be utilised in several ways and normally some or all of the effects below should take place. Some of the increased profits may be redistributed through the industry as increased wages to employees;

Or, the increased profits can be used for additional investments and production, purchases of inputs and services, creating spin-offs in input providing and output using industries and so promote economic growth. Economic growth has a positive effect on employment and poverty reduction as discussed earlier.

Or, the increased savings may be passed on to the user of the output in lower sale prices. If the users are low-income groups then it improves their incomes. In all cases the increased competitiveness of the sector should lead to higher production and employment.

Or even in the worst case, where the profits are only accrued by the owner, who may not be poor, it will lead to higher profitability for the sector, which in turn will lead to expansion of production by others.

Health

As the pottery industry is clustered, the emissions from its factories, stemming from large quantities of fossil fuel burning, tend to have large negative local environmental effects. Small plants, in general, are more pollution-intensive per employee, and presumably per unit of output (Dasgupta et al. 1998). By reducing energy requirements through the introduction of energy efficient technology and conservation practices, lower levels of pollutants such as NOx, SO2 and airborne suspended particulates will be present in the area (in addition to the global benefit of reduced CO2 emissions). This benefit will be of greater importance to the poor, as they generally live in the proximity of these polluting factories. Pollution-intensive industries have a tendency to locate in low-wage areas (Dasgupta et al. 1998) for various reasons. Firstly, pollution regulation in often weaker or absent in poorer regions (Pargal and Wheeler, 1996; Wang and Wheeler, 1996; Dasgupta et al. 1996). This may be due to the lower relative value assigned to environmental quality by the poor, and/or because low-income communities may be less informed and/or less organised to regulate pollution effectively (Dasgupta et al. 1998).

Education and skills

Any improvement in energy efficiency will require higher skills of the workers. It is assumed that important training and education benefits can accrue to the workers on energy efficiency and conservation.

Access to decision making

A key aspect of the project is the participatory process to be used and the discussions with pottery industry workers.

Risk and vulnerability

The problem of risk, as Kanbur and Squire (1999) identify, is that it keeps the poor in low-risk, low-return activities and it endangers what they already have. One of the greatest barriers to investment in new (higher-risk, higher-return) technology is access to capital and this problem is even more acute in poorer industries. By providing both the information and energy efficient technology, the project reduces the risk level for pottery entrepreneurs. This gives them access to a high-return activity with a reduced corresponding risk. It also reduces of the owners and workers to future risks of not meeting higher environmental standards and risk of not being competitive with other sectors for domestic and export markets.

Following Bruno et al.'s (1995) conclusions, then by allowing the poor to make productive investments through either lowered credit constraints or by increasing the available information about new technologies, this leads to a higher and more equitable growth process.

Sustainable Development

Overall, the project promotes sustainable development strategies. According to Repetto (1986, p. 15), "sustainable development [is] a development strategy that manages all assets, natural resources and human resources, as well as financial and physical assets, for increasing long-term wealth and well-being. Sustainable development, as a goal rejects policies and practices that support living standards by depleting the productive base, including natural resources, and that leaves future generations with poorer prospects and greater risks than our own." More simply put, the Brundtland Report states "Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (World Commission on Environment and Development, 1987).

As the main energy source for the pottery industry is derived from the burning of non-renewable fossil fuels (as is the case for most other industries and consumers), this practice is both polluting and unsustainable. By finding energy efficient technology for the pottery industry, this will lead to decreased energy consumption and consequently will reduce polluting emissions.

The use of energy and its implications are of increasing global and national policy concern. These concerns stem from the perception that a number of human activities and developmental goals and objectives are not sustainable under current and existing "Business as Usual" policies and practices, especially with regard to the uses of energy. A detailed critique of developmental trajectories that are not sustainable are found in the (Bruntland and Agenda 21).

Global environment, development and poverty

Specifically with energy, the current energy use patterns and their anticipated growth, and the need to reduce global greenhouse gas (GHG) production and attendant warming have become important. The major GHG, carbon dioxide, is produced by the burning of fossil fuels for heat and energy (for more details on the sources and production of individual GHGs, see IEA, 1994; IPCC, 1991; and PRI, 1995). Carbon dioxide is the main anthropogenic greenhouse gas and is estimated to contribute over 55 per cent of the greenhouse effect. It is produced largely from the burning of fossil fuels; over half of the emissions come from energy sector activities. The International Energy Agency's 1994 *World Energy Outlook* (IEA, 1994d) projects a global increase of almost 50 per cent in carbon dioxide emissions between 1990 and 2010 if there are no new policies, technologies or strategies to significantly alter energy supply and demand patterns. If these are not addressed the resultant warming is likely to have a number of negative impacts which will reduce the future security of the poor (and the rich also, but always the poor suffer more as they have less capacity to mitigate risks).

National level issues

The large anticipated growth in energy demand confronts developing countries in general and India and Ghana in particular, with financial, operational and environmental constraints independent of any consideration of carbon emissions. As the U.S. Office of Technology Assessment writes, "commercial energy consumption in developing countries is expected to triple over the next thirty years," which has many attendant costs (OTA, 1992). Beyond the issue of greenhouse gases, and the possible impacts of climate change, many developing countries already suffer severe environmental degradation and negative effects from their energy production. Emissions from the burning of fossil fuels for industry, transportation and power generation are the largest sources of urban air pollution and add particulates, sulphur dioxide (SO_2), nitrogen oxides (NO_x), carbon monoxide (CO) and other pollutants. World-wide, the cities with the poorest urban air quality are in the developing countries; with increasing urbanisation and energy production and use, this situation will deteriorate even further if no ameliorative measures are taken. Even the relatively clean resources from the point of view of emissions, such as hydro power, flood agriculture and forest lands, force resettlement of people, usually the poor, and disrupt their local environment for sustainable livelihoods.

Taking again a specific case from India, this project was to first examine the energy efficiency opportunities in the small foundry and glass sectors in India. In both these cases the current practices which are highly polluting and energy inefficient have drawn strictures from the courts for violating local pollution standards and many units are threatened with closure or have closed. Under the circumstances it was decided to select an alternative sector which is not under similar crisis conditions. Clearly the losses of employment for violations of environmental quality affect the poor workers in these industries more than the well off consumers.

For all countries, and especially for developing countries, energy and economic development are closely linked; their economic growth, the primary method for eliminating poverty, requires a growth in energy services. Policy makers everywhere are concerned that energy services, which are too expensive, will affect employment, growth and development negatively. Both India and Ghana currently have significant energy shortages, in the range of 30-40%, unreliable and poor quality of energy infrastructure and production, and high inefficiencies. These in turn result in high economic costs because of material wastage, low-capacity utilisation, and investment in standby equipment as a stop-gap measure. In most countries, it is argued, improved production and use efficiencies, promoted and implemented through appropriate policy reforms and technological applications, could reduce total energy use by over 50%.

Improving the economic efficiency of energy production and end-use has the potential to allow developing countries to meet their economic growth and improved living standard needs with their own economic, financial, operational and environmental resources. This is a classic "win-win" option in which the economic needs of developing countries would be matched with their environmental needs and also the global need to reduce carbon emissions.

One principal direction to the solutions to the energy dilemma faced by developing countries (and industrialised countries) is to treat their energy, economic development and growth strategies with environmental problems as interrelated issues and look for more immediate solutions to all three. This calls for increasing the energy efficiency of all energy uses, reducing, where appropriate, the demand for certain energy-intensive uses and generating and transmitting the reduced requirements of energy with the best combination of high technical efficiency, high economic efficiency and low environmental impact.

Very often measures to increase energy efficiency per unit of output in industrial production activities are highly correlated with an over all increase in production efficiency. Therefore increases in energy efficiency are likely to be accompanied by lower inputs of other materials, lower wastes, and reduced pollution loads. Besides the issues specific to energy production and use, there is a concern that unless the impacts of economic and production activities are reduced, they will increasingly generate environmental constraints which will further limit the scope for economic development besides their negative impacts on the health of human and other living things (World Commission, 1987). More efficient and cleaner technologies are those designed to reduce the throughputs and waste streams of energy, water, materials and by products and these provide developing countries, the choice, often termed "leap-frogging," to follow less polluting options rather than using outdated technology.

Furthermore, this project offers a potential for improving the technology services provided to small and medium industries. SMMEs, which provide the maximum amount of employment in all countries and are seen as a major element of any employment generating developmental path. At the same time, small and medium size businesses tend to be less efficient and more polluting (per unit of production) than many larger units

and do not have the in-house capacity to resolve their technical problems. So we need to review the special role of SMMEs in the growth and employment generation strategies and their special problems and needs.

Small Enterprises

If we apply a comparative framework to development, and accept that in certain respects the development path followed by Developing Countries (DCs) will include some of the same elements and follow some of the same trajectories as traced out in the industrialised countries, then the following historical facts may be considered to be valid. Historically, in all societies agriculture and food production engaged most people, and farm and farm related services provided the locus of most employment and defined social organisation (English, 1993, p. 3). In all countries additional employment opportunities emerged first with increased farm production and with related off-farm industrial production, both demanding complementary services. It is natural for all such additional production activities to start in the most part in small establishments, some in rural and some in urban areas. It is only in the later stages of development that many of these small establishments grow to become large, so that in the industrialised countries a high share of all employed persons work in large establishments.

The definitions of "large," "medium," "small" and "micro" establishments vary considerably across countries and in many countries there are legal definitions for the different size classes. Nevertheless, we accept English's (1993) argument for a very rough and ready definition that large enterprises are those with more than 100 employees.

Over time, with industrialisation, there is a movement of labour from the farming sector to manufacturing, with a growth in SMMEs and their employment share. Ultimately the structure of employment and firms in the industrial sector stabilises with a certain distribution between larger and smaller firms. This structure and distribution, always a dynamic one, depends on the history, economic policy and industrial environment, within which different sizes of firms exhibit optimal economic efficiency.

The economic logic for the initial growth of SMMEs is based on the initial scarcity of capital. This is true for all new entrepreneurs in all countries. And, capital scarcity is a more common characteristic for most entrepreneurs in DCs. In DCs there is a greater dependence on labour intensive technologies that form SMMEs. Over time some of the SMMEs move toward more capital-intensive technologies as their supply of capital increases. Since capital-intensive technologies tend to be characterised by economies of scale, large firms evolve and become dominant in many sectors over time. It would clearly be inefficient if no SMMEs ever evolved to become large firms as then possible economies of scale would not be availed.

So while the importance of the small-scale sector may diminish as a country becomes more industrialised, the fact remains that at the earlier stages of development the sector is efficient, and is a good place to invest resources from the national point of view, therefore, it is a sector which deserves public support. The fact that there is not enough capital to go around in DCs (i.e., not all workers can be allocated similar amounts of

capital as in industrialised countries) leaves a country with two alternatives. It can concentrate a high share of its capital on a few workers, who will have high labour productivity and high wages and leave the rest of the workers with very little, or it can attempt to distribute the capital more evenly among all the workers (English, 1993, p.6). Normally one can get more total output by using all of the workers together with intermediate technologies than allowing a few to work with advanced technologies while the rest have so little capital that their productivity is very low (English, 1993). Intermediate and less capital intensive technologies are used in SMMEs to a much greater extent than in larger enterprises.

Among the most commonly stated rationale for the support of smaller production units is their employment creating capacity. This almost universal phenomenon arises from the fact that generally for the same product SMMEs use greater labour and less capital and as well that in most countries most start ups are in SMMEs. Also, SMMEs usually hire a work force with lower skills and thereby provide a large number of unskilled workers valuable work experience and skills. Evidence also shows that SMMEs often tend to use more appropriate technologies, produce products with more appropriate attributes and at scales more suitable to small DC markets. Finally, it is postulated that unlike the larger scale manufactures who rely more on imported technologies, the SMMEs can provide the main market for the research and technology development capacity of DCs. Recognition of the importance of the small-scale sector (SMMES) increased almost two decades ago together with a better understanding of technology issues and the nature and pervasiveness of employment and poverty problems.

The potential socio-economic contribution of small manufacturing enterprise is great and will remain so for some time in most parts of the Third World. The countries which have shown exceptionally high economic growth rates, high employment rates, and a more equitable income distributions have been Japan, Korea and Taiwan, and all of them have depended on a strong base of small enterprises. In the poor countries around the world, it is clear that this sector must play an important role for the foreseeable future if they are to increase their economic growth rates while increasing employment opportunities and equity.

The earlier arguments may suggest that SMMEs are only important in the DCs and not in the industrialised countries and that in the latter they are only of historical interest. That would be a mistake as the SMME sector is also a high priority for policy makers in the industrialised countries because most new enterprises necessarily start out small. This is due to initial lack of capital for start-ups and also due to the fact that in many new products and technologies initially the future markets are undefined or remain to be created. Thus, initial production is necessarily undertaken at a smaller scale. If the circumstances are favourable the SMME sector grows to take advantage of larger markets. Many new science-based technologies are scaled up from the laboratory and the initial production scale-up is often necessarily small.

Another reason for the importance of SMMEs is that in many sectors production that is closely co-ordinated between large firms and many small subcontractors have proven to be more economically efficient than that undertaken by vertically integrated large scale firms alone. Other advantages of SMMEs are that their development is important for the

promotion of regional economic development. It is also argued that small enterprise development is important for the more efficient functioning of the market by increasing the number of participants and reducing dominant power. Finally, it is argued that small enterprise development promotes democracy and a civil society by increasing the participation by larger numbers of stakeholders in the economic, political and social systems. (Additional discussions of the reasons for support to SMME can be found in the ILO Reports and English 1993).

All these advantages and benefits of SMMEs do not come without some attendant costs. In many cases it is understood that the economic penalties of not taking advantage of scale economies when available are simply too high. Even where SMMEs are economically attractive on various grounds they tend to be higher polluters than larger enterprises per unit of production, and given their geographic dispersion and lower capital and skill base, provide greater challenges for pollution control strategies. In general they are weaker in their capacity to generate savings and to generate technological change. As in the case of small farmers it is generally accepted that a healthy, efficient and dynamic SMME sector necessarily requires the provision of technological inputs from outside the sector.

In addition, some SMMEs in India, by virtue of producing predominantly for low-income groups are not concerned with improving product quality and/or production processes (Sharma 2001). However this situation cannot be expected to continue indefinitely given the economic liberalization policies currently being pursued by the India government and related competitive pressures of globalization. Finally, the reality of health, safety and working conditions, and pay, for SMMEs is in general inferior to conditions in large enterprises, although at the macro economic level it may be more “appropriate.”

Win-Win Situations

One of the ideas with which this project was started was an inspiration from some of the work done in India and elsewhere to promote cleaner production processes.

Generally, technology can be considered cleaner and environmentally sound if it:

- Increases efficiency in the use of raw materials and energy;
- Eliminates or reduces emissions of harmful wastes generated in production and ensures minimum hazards to human and ecological health;
- Promotes the reuse and recycling of inputs and final products, and ideally,
- Increases economic growth and expands employment opportunities, while being sensitive to the resource endowments.

Earlier responses to environmental pollution, which included either ignoring the problem, diluting and dispersing the pollutants or controlling ‘end of pipe’ emissions, have all proved inadequate. This has led to the emergence of the “cleaner production” paradigm, and approaches which prevent pollution in the first place, via changes of production

techniques, reduction in materials and energy throughputs, and more efficient production. Applications of cleaner production technologies typically start with simple audit procedures, and move on to improved housekeeping. This is often followed by modifications of products and processes, and applications of new scientific and technological principles.

There are many examples which are now available where cleaner production approaches produce 'win-win' situations for the firms, the economy and the environment. UNEP (1995) provides examples of cleaner production across 15 sectors from 30 countries, and Modak (1995) summarizes a number of additional cases:

> One machine tool factory spent $350,000 in redesigned processes to meet environmental standards and recouped $900,000.
>
> Monsanto and Dupont, both chemical companies, have reported saving hundreds of millions of dollars annually, and reducing discharges of pollutant by an order of magnitude through the use of these principles.
>
> An Austrian printed circuit board manufacturer saved over one million dollars, (2% of total revenues), and, over 50% of acids used by the application of process analysis and good housekeeping.
>
> In Chile, a textile dying plant used new monitoring and recycling technology for distillation, fermentation and energy re-cycling for savings of over $5 million per year.
>
> In Denmark, a cotton bleaching plant replaced reducing agents with an enzyme based process for a cost saving of $15-30 per ton of fabric.

There are also a smaller number of efforts which are specifically targeted at small and medium enterprises (SMEs) and which report similar promising results.

> The PROPEL project in Colombia assists SMEs in Bogota engaged in leather tanning. Through the adoption of recommended measures, the project reports that there has been a 50% reduction in discharge of suspended solids, a 30% decrease in water consumption, an increase in profitability of $2.00 per hide, resulting in a pay back of 1.5 months for the costs incurred by the firm.
>
> In India, a small paper producer introduced a series of process modifications and new technology to get higher quality, reduced pollution and attained cost savings of $120,000 per year. Another small producer saved $35,000 per year with an improved furnace design.
>
> A group of projects in the Philippines indicated a savings of 10% in costs and 50% in reduced emissions.

The general conclusion is that the in a variety of situations, cleaner production approaches can lead to reductions in pollution levels of 50-100%; to reduced use of energy, water and other material; and at the same time to increased economic gains for firms, with pay-back periods of a few months to a few years. Yet the take-up of such

opportunities by firms is relatively slow. While the reasons are not obvious, it is believed that some of the important barriers are institutional, resulting from the nature of the market for environmental technology and services.

In fact, a review of the UNEP case studies of the applications of cleaner production principles shows that energy efficiency improvements are *always* a component of the improvements and contribute greatly to the financial gains from improved performance (UNEP, 1994; 1995; and Modak, 1995).

In almost all industrial and institutional sectors there are a range of technologies available which can reduce contamination, cut down on waste, and improve the efficiency of use of raw material inputs. There is also evidence that firms can in many cases realise savings in operating costs by applying such technologies, with the result that initial capital costs can be recouped in a relatively short time-span. The range of such "cleaner" solutions spans not only new machinery and equipment, but also "softer" options (re-engineering of processes, housekeeping measures) which can be implemented with minimal capital costs. Yet the spread of "cleaner" technologies in developing countries has been relatively slow, and is slower still among small- and medium-sized enterprises (SMEs) - which are among the most important sources of pollution. The reasons are many but the most important variables include the lack of financing, the lack of information about available technological options, and the absence of key supporting structures.

One institutional innovation which may hold out promise as a means of offsetting some of the risk is what in Northern countries have come to be known as "energy service companies"(ESCOs). To date, there have been few little or no experimentation with such mechanisms ESCOs in developing countries. Yet there is likely to be considerable scope for this kind of an innovation, for the reasons outlined above. All of these factors, together *allow for the possibility of the emergence of specialised agents which can bring together the necessary skills and provide performance guarantees, thereby removing the skills and knowledge barrier; develop alternate methods of financing such projects, so that the user does not bear the initial capital expenditure; and agents which recover the costs incurred from the stream of savings arising out of increased efficiency, and sometimes, from the differences in assumed cost of capital*. *The development of such institutional structure is clearly an organisational innovation, that needs to be promoted through public policy.*

Concluding Remarks

Given the large number of issues sketched out above, most of them *cannot* be dealt with directly and in great detail in this project. The project aims to focus on a series of studies to examine first, whether there is in fact a large gap in energy efficiency as achieved in actual practice and what is technically feasible and economically rational, in the two sectors in the two countries. Preliminary analysis suggests that this is indeed so. Second, given that large gaps in fact exist, what are the causes of these gaps, that is, what are the specific barriers to technology adoption of more efficient practices and

processes? Third, to what extent can these potentials for economic and environmental gains be attained and what is the role of the present institutions in realising these gains? Fourth, what lessons emerge from the experience of attempts to improving the economic and environmental performance?

A principal hypothesis of this study is that there is an important need for institutional innovations, and in particular, the development and strengthening of intermediary institutions, which can mediate between the available solutions and the needs of the users. We refer to these as Energy Service Institutions/Intermediaries (ESI) in the case of energy and more broadly as Intermediary Technical Service Institutions.

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