Energy Provision to the Urban Poor

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ISSUES PAPER OUTLINE

1. INTRODUCTION

With high growth in urban populations, there is increasing pressure on the infrastructure and resources of the rapidly expanding cities of developing countries. Access to energy resources for cooking, heating, mechanical power and lighting, which are basic requirements of life, impacts significantly on poor urban communities and their environment. The choice and consumption of fuels for household energy in urban areas are complex matters, affecting household income, family health, social structure, local and national environment and technology choice. There is increasing urgency to address the issue of access to energy resources, and it is essential to share recent experiences and new ideas to promote a more sustainable and acceptable solution to problems of energy provision in urban areas.

Consequently, DFID identified this area as a future priority for its projects on urban poverty, and commissioned this study to inform on going projects in the urban sector. The main objective of the project has been to identify the options for increasing access for the urban poor to higher grade and more sustainable forms of energy.

2. STUDY OUTLINE

Over the ten months of the project, a number of activities took place to gather expertise and knowledge on energy for poor urban communities. The project had the additional advantage that some of the activities facilitated information exchange between development professionals, in addition to the data collection role. Five initiatives were taken, as described below. Full documentation of these have been provided to DFID.

Boiling Point Issue on 'Household energy: the urban dimension'

Boiling Point is a long standing publication, produced by Intermediate Technology, which is targeted at those working with cook stoves and household energy in developing countries. Its main audience is development workers in the South, though it does also have a policy influencing role. A recent impact assessment of the journal shows that it does influence both practice and policy. The issue on urban household energy included eight articles, covering a range of urban energy issues in Asia, Africa and Latin America.

HEDON meeting on Urban Household Energy

HEDON is the Household Energy Development Organisations Network. This is a grouping of leading international organisations which are actively promoting various aspects of household energy for developing countries. The group meets annually to discuss a current topic from various perspectives and to exchange experiences. IT hosted the two day meeting in September 1998, with the central topic of urban energy.

Country Case Examples

The project commissioned case studies from five countries, as shown in the table below.

Country Case Study	Consultant
India	ERM India
South Africa	Energy Development Research Centre (EDRC)
Kenya	IT Kenya
Peru	IT Peru
Mali	Consultant Andreas Massing, with support from GTZ

They were asked to focus on the following themes:

- Access to energy (especially non-technical barriers)
- Low cost electrification options
- Energy for small enterprise
- Cooking fuels and technologies
- Energy service provision (supplying energy needs)
- Economics of energy for the urban poor
- Health and environment

Each country examined two or more of the themes in detail, using primary and secondary data sources. Country specific and cross cutting recommendations have been made in each of the case studies. High quality reports have been produced by the consultants in each country.

Waste to Energy Workshop

Through research and networks, a number of experts in the field of urban waste management and of waste to energy conversion were identified and invited to a workshop at Intermediate Technology in February 1999. This unique event brought together about 30 experts from varied disciplines together to discuss the potential for using urban waste as an energy resource for the urban poor. Key note speakers from India, Sri Lanka, Pakistan and Cuba presented the current status of waste management and waste to energy in the South.

Literature Review

While the above activities managed to gather information from a wide range of expert sources, it is always essential to review the existing literature, to ensure the topic has been cover in full.

This paper compiles the key messages from these activities, and details the recommendations which have been made throughout the study.

3. POVERTY AND URBANISATION

Poverty and urbanisation are linked to the extent that many of those who can be classified as poor are often recent migrants from rural areas. Urbanisation is continuing on a larger scale than ever occurred in the industrialised world. By current estimates, Africa's urban population is currently growing at 5% a year, and is set to continue at this rate into the next century; South Africa's urban population is in the majority. India also has one of the largest urban populations in the world, constituting over 25% of its total population and increasing at the rate of 3% per annum.

Causes of urbanisation vary from country to country and from city to city: in India, rapid industrial growth during the past four decades and the need for labour has encouraged the flow from rural areas; in South Africa a similar picture exists, complicated by past restrictions on the movement of labour; in Mali and Kenya, as in many other African countries, the search for better opportunities in urban areas due to a stagnation in the rural economy, droughts and political upheaval are the drivers.

Rural-urban migration is often 'circular' – single male migrants travel to urban areas for work, they maintain close links with their villages of origin, they return when they can or when forced to, and they aspire to return after retirement. These migrant workers, more often than not landless and living in non-permanent settlements, form part of the Poverty Pyramid, but not the poorest section. The Poverty Pyramid can be used as a generalised model to describe the constituent parts of the urban poor. Women and children, the frail and the old dominate the largest group. Next come the labouring poor, who largely rely on the sale of their labour as unskilled workers or are involved in scavenging or recycling activities and do not benefit from stable full-time employment. The self-employed poor, who form part of the 'informal sector', are materially better off than the first two groups, but are economically and socially part of the larger group of 'the poor'. The entrepreneurial poor may be better off still, but their income may still not exceed the poverty level.

Each country has its own definition of poverty, and generally these measures put the number of poor above that calculated by the strict World Bank definition of 'less than a dollar a day' (at 1985 currency levels). Relative poverty measures, such as 'persons coming from households with a total cash income less than one half of the national average' are generally favoured, but these ignore two important factors. These being that poverty can also be measured in terms of non-monetary or 'quality of life' factors and the cost of living is generally higher in urban areas. In urban areas acquiring a source of energy is almost exclusively a commercial activity: the poor generally pay more per useful unit of energy consumed and subsequently suffer the most when prices increase (structural adjustment programmes have generally pushed prices upwards over the last decade).

The case studies presented highlight the natures of urban poverty in the cities studied and reinforce the statement that the character of urban poverty is dependent on local (or national) circumstances. In India, the urban poor generally live in slum conditions that constitute over 25% of the urban population, but not all the poor reside in slums just as not all in slums are poor. Pavement dwellers and the homeless constitute the poorest, but actual figures are difficult to find due to the lack of attention that has been paid to this sector of society. In South Africa, 50% of the urban population are poor by their measure of poverty. The freeing of the restrictions on the movement of labour into cities, accompanied by a backlog in infrastructure improvement, has displaced much rural poverty into urban areas. In Mali, farmers who could sustain a livelihood through their connection with the land in the past have been forced into urban areas because of a succession of crop failures and other instabilities. They then become landless and dependent upon casual work or scavenging activities. Urban poverty in Kenya is manifested in the form of increasing street children, single parents with large families, poor households living in slum areas and informal settlements, and unemployed youth. Peru, on the other hand, has been experiencing the urbanisation process for a relatively long period; many families have access to fuels such as kerosene and LPG and water and sewage services, but incomes are still low classifying many as materially poor.

Thus, improved energy provision to the urban poor will depend largely on the location and nature of poverty, existing energy use patterns and should form part of a general poverty relieving strategy.

4. ENERGY ISSUES

4.1 Rural/Urban Links

Cities grow with an increasing dependence upon their hinterland, whether they are situated in the North or South. Urban conurbations rely almost entirely upon the transport of products and services that have been derived from natural resources outside the cities. Energy resources are no exception. Biomass fuels are usually brought in from the surrounding countryside. Fossil fuels often require importing from without national boundaries. Electricity generation also rarely occurs within city limits, but cities are often the first, or only, areas to be electrified.

The main energy-related connection between rural and urban areas is through the supply of wood and charcoal for cooking. This relationship can be detrimental to the environment if the process is not managed effectively. Fuelwood usage in urban areas has a greater negative impact on the environment than its use in rural areas. When wood acquires some monetary value it is in the interest of the supplier to sell the parts of the tree with the highest value and not just those which will ensure the trees long term survival. Thus whole trees will be cut rather than using dead wood and prunings. The predominant use for charcoal is in urban areas, and this again necessitates the use of whole trees. Charcoal production also uses substantially more wood than would be used by direct burning. Both wood and charcoal require transport over long distances, which itself uses a lot of energy (often fossil fuels).

Biomass use in urban areas of many developing countries has such a major effect because it is the one type of fuel which everyone has access to. To the poorest, direct burning of wood is the only economic way to cook and provide heat. To the poorest in rural areas it is often the major source of income. Migrants from the countryside to the city often continue to use fuelwood in the same way through habit and inability to afford more expensive fuel and appliances. There is conflicting evidence about who profits most from the supply of wood and charcoal to urban areas. There is some suggestion that urban-based traders profiteer at the expense of rural suppliers who do not know the true cost of the resource, while others suggest that there is a more equitable distribution of income from the sale of wood and charcoal. Wood and charcoal prices are determined by a number of factors, including:

- local supply and availability
- their relative cost compared to the next highest grade of fuel available, usually kerosene, coal or LPG
- seasonal availability of fuel (often low availability in the rainy season)
- subsidy levels and other fiscal measures applied to fuels.

Each rural/urban relationship is likely to be different. What is a given is that the rural poor benefit, in varying degrees, from the use of biomass-derived fuels in urban areas. Any moves to change the flows of these resources from the countryside to the cities should address the question of providing incomes in some other form to the rural poor.

The historic focus on the supply of energy for rural inhabitants has sometimes ignored the effect that cities have on environmental degradation. The dependency of urban settlements on their rural hinterlands for fuel needs to be addressed; this in turn will help alleviate fuel shortages felt by rural populations. When considering energy strategies the division between urban and rural areas should be questioned; a focus on energy flows in general would be more appropriate.

Recommendations*:*

- *The supply of energy to urban areas should be considered in the round, with regard to the effect felt by all stakeholders.*
- *establishment of guidelines for forest use for the supply of fuelwood and charcoal;*
- *improved charcoal production techniques should be employed;*
- *improved data collection, resource monitoring and control systems;*
- *participation by local inhabitants;*

- *improved stove programmes for urban dwellers could contribute significantly to improved demand management;*

- *the clearing of land in peri-urban areas for agriculture or development should be regulated with a view to maintaining/establishing forest resources.*

4.2 Fossil Fuels – LPG and Kerosene

Almost all urban areas are at some stage of transition from biomass fuels to fossil fuels for the domestic sector, small industry and enterprise activities. For cooking and heating liquefied petroleum gas (LPG) and kerosene are the most common fossil fuels used, with coal and butane gas used in a few countries where they are more commonly available. Kerosene is the most common lighting fuel for households which have no access to electricity. Diesel and petrol are used in small industry for generators and mechanical power. Small enterprise uses are discussed in a later section.

The country case studies provide careful documentation of the fuel transition and the influences which affect the rate and pattern of transition. It is evident that some cities are in the early stages of transition and still have a high dependence on biomass fuels. For example in Nairobi charcoal is the main cooking fuel, while in the cities of Mali predominantly use fuelwood, with only relatively wealthier households using fossil fuels for cooking. The Indian case study shows that cities in India are in transition from biofuels to fossil fuels, with the choice of fuel highly dependent on household income and fuel accessibility. Lima on the other hand has moved almost entirely to LPG and kerosene for cooking fuels. This fits well into a the 'Three-Stage Model' identified by the World Bank ESMAP, which clearly describes these transition phases.

There are a number of advantages of using LPG and kerosene over biomass fuels. Replacement of biomass fuels in urban areas will help to reduce the pressure on the forest resources around cities. Fossil fuels are more convenient to handle and use, they emit less harmful pollutants into the kitchen and they significantly reduce cooking time. The main disadvantage of fossil fuels is that most developing countries do not have their own fossil fuel resources, and therefore increased dependence on the fuels increases the dependence on imports and foreign exchange.

The transition to fossil fuels for cooking takes place for two main reasons. First when household incomes increase there is a preference to move to kerosene (which, where available, is usually cheaper), and to the more versatile LPG. The second motivation for the transition is due to limited access to biomass fuels. As availability of fuelwood and charcoal reduces in a city (usually due to deforestation around the city), the price of the fuel increases and its accessibility reduces, so kerosene and LPG become more economically attractive. However, there are a number of other factors which influence the affordability and accessibility of fossil fuels in urban areas. Choice of fuel is strongly influenced by:

- Subsidy and taxing of fuels: Subsidies and taxes on different fuel have a very significant impact on the market for fuels, and therefore must be very carefully targeted. The country case studies show that subsidies often benefit the better off, who have greater access to the subsidised fuels and more buying power to purchase larger quantities of fuels.
- Distribution and supply systems: Publicly controlled distribution of fuel is often inefficiently managed, therefore reducing access for the majority of the population. For example rationing of kerosene from government sources in India limits access to the fuel at an affordable price. Counter to this, a black market in fuels will often raise the price of fuel above the reach of the poorest in a community. The Peru case study shows that competitive private distribution of the fuels has meant more outlets for fuels, and hence greater access for every one in the community.

At the household level, pattern of fuel use is influenced predominantly by income. The relatively high cost of equipment, and, in the case of gas the cost of a large cylinder, are the most common reasons why poorer households cannot access higher grade fuels. Even in some households which have LPG stoves, kerosene is still used when household income is low. Kerosene can be bought in small quantities on a daily basis, whereas LGP has to be purchased in large quantities up front. Because the poorest in a community will purchase small amounts of fuel, often on a daily basis, they tend to pay a higher unit price for fuel than better off households who can afford to bulk buy. Therefore there is an urgent need to implement financing options which will allow the poorer in a community to access higher grade fuels on a regular basis. For example, in some countries, such as Ghana, smaller quantities of gas can be purchased at cheaper rates.

For many household and industrial uses the next fuel transition is to electricity, as discussed in the next section. However, this is not the case for cooking and heating. It is clear that the cost of energy and appliances is main reason why kerosene and gas remain the first choice for cooking, even where

electricity is available. Diesel use for generation and mechanical power is common where there is very poor access to electricity or where the reliability of grid electricity supply is poor.

Recommendations:

- *Subsidy and taxation on fuels must be carefully designed to achieve actual policy goals, and not to bias access to higher income households.*

- *Widespread access to fuel supplies is as important as fuel cost in encouraging the transition to modern fuels. Equity of access across the community must be addressed if the poor are to access higher grade fuels.*

- *Appropriate finance mechanisms for equipment and fuel supply should be considered to allow a wider economic group to have secure access to higher grade fuels at a lower unit cost.*

- *Smaller cylinders for LPG and filling stations which supply smaller quantities of LPG.*

4.3 Electrification

One method of increasing the quality of life for the poor and of removing their dependency on fluctuating local fuel prices is to provide households with electricity. For lighting electricity is often cheaper to the user than using biomass or kerosene and is cleaner to use. Electricity is also the preferred choice for many small industries. In addition, there is the longer term prospect that electricity supplied to the poor could be generated efficiently using renewable energy.

Rates of electrification are higher in urban areas than in the countryside due to the concentration of population and consequent reduced transmission, distribution and tariff collection costs. Despite this, there are still substantial proportions of the urban population in many countries with no access to electricity, and those that do may only use it intermittently. In South Africa, where the electricity utility is the world's fifth largest, thirty percent of the urban population are without electricity, and even those who are connected continue to use a combination of energy carriers including LPG, paraffin and wood. In other respects, the South African model illustrates the success of some implementation mechanisms. Ambitious targets have been set to electrify low-income households in urban areas and innovative techniques have been used to connect poor households. In India, some slums may be totally electrified by a combination of illegal connections, for which the utility receives no income (although middlemen who make the illegal connections do), and connections to private generators.

There are several problems associated with electrifying the poorest neighbourhoods. Electricity utilities can face large capital costs associated with constructing new, or paying for existing, generating plant. Their ability to recoup this investment through the use of connection charges is impaired by the inability of poor households to afford up-front payments. Low revenues actual or anticipated, from poor households may be insufficient to cover collection costs; utilities may be constrained by government to limit the tariffs for poor consumers. Distribution costs, even in urban conurbations, may be too expensive to merit connection. Illegal connections can also be a problem, deterring utilities from connecting some neighbourhoods.

To the potential consumer, there are also barriers preventing access to electricity, even if there is a distribution network close at hand. High initial connection charges and the high cost of house wiring are the two main deterrents, followed by high standing charges. In South Africa, electrification is limited to those households that have legal tenure, which exclude a substantial proportion of the poorest. Even when connected the use of unreliable second-hand appliances (which are cheaper to purchase than new) and the irregularity of the supply forces many to use kerosene or wood as an alternative supply of energy. The South African study also highlighted the lack of information available to people introduced to electricity for the first time. This led to it being used inefficiently. In Indian slums, even when deposits had been given to the utility, no progress had been made up to two years later to install meters. This was despite there being a willingness amongst consumers to pay a higher price for electricity than they were currently doing, to ensure a legal and reliable connection. This proved a disincentive to others to pay for a connection.

Recommendations*:*

- *There are several technical options that can be used to help reduce or eliminate the problems outlined above. These include the use of prepayment meters, prefabricated wiring systems and load limiters.*

- *Credit provision to the poorest to enable them to budget for connection costs and house wiring should be developed.*

- *Community associations, where necessary, should be recognised as a legal entity to deal with utilities.*

- *The provision of basic appliances, or fiscal measures related to the sale of efficient appliances, in co-ordination with the connection to the supply and/or credit programmes should be encouraged.*

- *Low tariffs for the first few kW hours of energy usage can encourage those with only limited loads (lighting, for example) to make a connection.*

- *Prohibitive standards should be reviewed which prevent connection to non-permanent dwellings and technologies employed to ensure safety.*

- *The policy of categorising slums as illegal settlements, and the consequent refusal of some utilities to provide legal connections, should be reviewed.*

- *Decentralised renewable energy technologies to provide electrification should be considered.*

- *Low cost solar water heating could reduce expenditure on electrical water heaters.*

4.4 Waste to Energy

The recycling of waste is an activity that already occupies substantial numbers of people in urban areas. Material that is initially discarded is identified as being of further economic value. The fact that this activity is largely unregulated by the municipal authorities masks the contribution to livelihoods and solid waste management it makes. There is potential to use existing mechanisms and markets to identify, sort and process wastes into a form where they can be used to provide energy. In this way, livelihoods are supported and an alternative supply of energy provided. The use of waste to provide energy on a small scale is an area that has not been researched in any depth and there is an insufficient exchange of information. Large-scale waste to energy technologies are commercially employed in many countries, mainly to raise steam for electricity generation. The technology has not transferred to developing countries totally successfully on a similar scale.

The importance of the waste management sector in acting as an informal social security system should not be underestimated. At the household waste components with value are separated for sale to itinerant waste buyers. Street sweepers who are employed by the municipality or who work collect waste that is left on the street privately on a patch of households. Street pickers sort through the waste for items of value, either at the street side or at waste dumps. Dealers purchase the sorted components from individuals or group leaders and it is resold to recycling industries. Dealers provide an income to waste sorters and buyers and sometimes extend loans during periods of low income.

Utilising waste to provide an energy source for the urban poor is an idea which raises several important questions. Paper, plastic, glass and metal are recycled because they provide an income for enough people for the activity to be economic and sustainable. Which waste components could be isolated at the street level to provide a similar income? There is evidence that waste material is collected already and burned by households as a substitute for fuelwood. To what extent can this process be formalised? Which is more important, the provision of an alternative fuels for the poor or the strengthening of livelihoods?

Waste can be used in two ways for the production of energy. The combustibles can be removed, concentrated or densified in some way and sold as a fuel to supplement or replace fuelwood. The organic components can be used in digesters for the production of gas. Examples exist of the use of waste in this way. In Sri Lanka, waste from vegetable markets is used to provide gas for generator sets. The electricity produced can be fed to the grid or used to energise mini-grids. The digested solid matter is used as fertiliser. In Cuba, an innovative programme exists to burn solid municipal waste to provide energy in the production of lime pozzolanic binders. The ashes from the waste are also used as a raw material in the process.

Recommendations*:*

- *Waste for energy to be used by the urban poor is an area that needs further investigation.*
- *Environmental health aspects should be thoroughly studied.*
- *Small-scale energy technologies that can utilise waste products, if appropriate, need development.*
- *Three issues should remain key in considering this area: health, environment and livelihoods.*

4.5 New Technologies

The application of new and renewable energy technologies have been widely piloted and promoted for poor communities in rural areas of developing countries. Less attention has been paid to the application of renewable technologies to benefit poor urban communities. The scope for renewable technologies within a city may be more limited than in a rural setting, as resources may be less abundant or more difficult to utilise. None-the-less, with the environmental and economic concerns of over exploitation in urban areas of both traditional wood and conventional fossil fuels, there seems to be a significant role for alternative energy sources. Two renewable energy resources which have greatest potential for urban application are biofuels (in particular biogas) and solar power (though at current costs and without subsidy, the introduction of solar photovoltaics in the poorest urban areas is still questionable). In addition, technologies for increasing energy efficiency have a role to play in reducing pressure on valuable resources. Many lessons can be learned from applications of new technologies in rural areas, though with the particular limitations and needs of poor urban people kept in mind.

The Indian case study discusses two renewable technology applications: biogas for community power generations and solar photovoltaic systems for individual houses. These innovations can help to overcome problems such as difficulty in connection to the electricity grid for informal or illegal dwellings, by offering an off-grid alternative. While technology development was one aspect considered, the case examples focus more on appropriate institutional and financial requirements for implementing the technologies in a sustainable manner. Community involvement in the projects is viewed as crucial to success. Participation instils a sense of responsibility and ownership for the project, which has been shown to be essential for success of many development initiatives. Suitable financing can stimulate a commercial marketing for products such as solar home systems, as well as opening up opportunities for lower income households to access these technologies.

Energy efficiency is addressed in the South African case study, in particular solar water heating and thermal insulation of houses. The case studies are all pilot projects, which aimed at demonstrating new technologies and awareness raising for energy savings. In one case solar water heating was provided to low income households with the main aim of reducing expenditure on water heating equipment in new homes and on daily heating bills. Solar water heating for a community hostel was also considered. A third case example was reduction of space heating needs in new houses for low income people through insulation and house orientation. The case studies showed that barriers to implementing energy efficiency technologies generally relate to high cost of new technologies, lack of awareness about possibilities and the need for community commitment. From these studies, cost reduction and community involvement appear to be critical factors for success.

The section above on waste to energy gives one example of an alternative use of an abundant urban resource. In particular, biogas production from vegetable waste has potential for supplying some community or household energy supplies. There is still significant research and development to be carried out to establish both technological and socio-economic feasibility. However, there remains a large potential for utilisation of an otherwise hazardous and wasted resource.

Recommendations:

- *Technology development for urban applications: There are opportunities for development of these and other technologies, such as biogas and energy efficiency technologies, to be adapted for urban application and for cost reduction.*

- *Promotion of new energy technologies: awareness raising with various stakeholder (user, financiers, policy makers and so on) will be essential for the introduction of new technologies.*

- *Addressing appropriate institutional structures, in particular community involvement: Innovative institutional mechanisms should be encouraged to involve local people as partners in the process of providing cheap and reliable energy. Local stakeholders should not only share the benefits, but also some responsibilities.*

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

5. RELATED ISSUES

5.1 Policy

The huge influence of national and local policies on access to energy for the urban poor has been evident throughout this study. As the Indian case study states:

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

The impact of policy changes can dramatically affect the most vulnerable in society, and will impact on a number of commercial activities. The country case studies give very clear examples of where policy has limited or increased access to certain fuels.

Subsidy and taxation

Taxes and subsidies have a powerful influence over the energy market. While having the desired positive effect, unexpected negative impacts can also occur. For example, subsidies for kerosene and LPG have encouraged a rapid move away from biomass fuels, which can result in a positive environmental benefit by reducing forest depletion. However, subsidies will not necessarily benefit the poorest, who cannot afford to purchase kerosene stoves, and also may reduce income generation for rural people who depend on selling wood fuel for a living. Also encouraging rapid change from biofuels to fossil fuels may have a huge knock on effect for employment in rural areas.

It is important also that duties and subsidies imposed by different government departments or agencies do not act against each other. This has been the case in Sri Lanka, for example, where duties on imports of solar panels have counteracted the benefits of World Bank subsidies for their purchase. On the other hand, duty relief for renewable energy technologies have had a beneficial impact in other countries, such as for the introduction of solar home systems in Nepal.

Distribution networks:

There is some debate about whether distribution is best done through the public or private sectors. Certainly many countries are moving towards liberalisation of the electricity market, with mixed results. On the whole there is an understanding that the private sector increases competition and, often, improves availability. However, an unregulated private sector is not the best way to improve access for the poorest in society, who are not able to pay the full market rates for higher grade fuels. Also quality control of energy products may be lowered if not regulated.

It must also be acknowledged that in some energy sectors the black market plays a very significant role. This occurs especially where there is poor access through official channels (such as limited electricity connections in slum areas), or where there is a highly regulated market (such as charcoal markets in Nairobi). While it is preferable to avoid the establishment of black markets, in many cases they are already well established. In such cases, it may be better to address the reasons why they have established, and possibly include the dealers in moving towards a solution.

Finance

Appropriate finance has been a recurring theme in almost all papers prepared for this study. One of the main limiting factors for the poorest to move to higher grade fuels has been the up front costs of purchasing new technologies, and also suitable payment schemes for fuel costs or tariffs. Financing mechanisms to stage payments and reduce financial risks for the poorest are needed before they can access higher grade energy supplies.

Suitable financing schemes will also be necessary for the introduction of new technologies, such as new renewable energy systems. Such technologies usually have high up front costs, but low running costs. Therefore innovative financing for communities and individuals to access these technologies will be necessary for such technologies to move from pilot schemes to economically viable options.

Legality Issues

There are many cases where legal structures have limited access to suitable fuels for the poor. A few common examples are provided here.

Limits on the production of charcoal in Kenya have had the effect, not of reducing charcoal consumption, but of increasing illegal charcoal production. This creates a black market for the fuel, which does not have controlled prices. While the limits on charcoal are necessary for limiting environmental impact, evidently they are not having the desired result.

The poor in cities in developing countries often live illegally on land, and in temporary or makeshift houses. In most countries, utilities will not supply electricity connections to such communities, even where there is willingness to pay. For example, the utility ESKOM in South Africa will only supply houses with legal tenure, this is the case in almost all developing countries. So even where there is willingness to pay, legal restrictions prevent access.

Urban Fuelwood Policy

While fiscal measures can encourage fuel switching and more efficient use of fossil fuels, wood and charcoal will remain the easiest and most accessible fuels for many of the urban poor to use. They have the additional advantages of not being a drain on foreign exchange reserves and, if harvested sustainably, do not add as significantly to greenhouse gasses. Improved public and private management of biomass reserves and supply systems must therefore be considered. The clearing of land for agriculture and building in peri-urban areas significantly reduces wood reserves; land-use competition issues should be addressed.

Recommended approaches towards increasing access to energy for the poor include:

- *Defining the problem is a first step towards effective policy. The Peru case study recommends that in order to develop suitable energy policy for poor communities, it is first necessary to define the energy supply situation for people without access, in terms of fuels used for cooking or domestic lightning, their costs and their health and environment impacts. Only then can real problems of access be addressed.*

- *Participative planning approaches to energy sector development for poor communities are recommended, to include a range of stakeholders of different income, age, gender and commercial sectors.*

- *Innovation in approaches for allowing poor communities to access energy supplies. For example, licensing groups of households or small businesses to access the electric grid, or develop community based renewable supply options.*

- *Innovative pricing and financing for the poorest in the community to access energy equipment and fuels may also open up greater access for energy resources.*

- *Monitoring of the impact of policies which affect access to energy is essential to ensure that the target recipients are in fact benefiting, and that there has been no negative impacts on any vulnerable sector of society.*

5.2 Health and Environment

Household, commercial and industrial sector energy use all impact on human health and the environment. Throughout this paper health and environmental issues have been key reasons for promoting changes in fuel use patterns from household to national level. Moving up the 'energy ladder' towards cleaner and more convenient fuels is desired by most people.

In terms of convenience, it is generally accepted that the order of preference for fuels, from most convenient to least, is: electricity, gaseous fuels, liquid fuels, solid fuels. However, there is some dispute over what constitutes the cleanest fuels. There are three environmental issues which dominate the debate over clean fuel. These are deforestation, global warming and indoor environment.

Urban energy consumption has had a huge impact on surrounding forest resources in a number of countries. Cutting of trees for fuelwood and charcoal for urban use is often done intensely and in an uncontrolled manner. There are two solutions to deforestation. The first is to encourage reforestation, so that forests are used in a renewable and more sustainable way. This will require strict enforcement of controls on forest cutting and replanting. The alternative is to move towards non-forest based fuels. Often a combined approach is taken.

In terms of global warming potential, fossil fuels and biofuels from a non-renewable source are viewed as the worst energy options. Gaseous fuels generally emit less greenhouse gas emissions than liquid or solid fuels, as energy conversion efficiency is much higher for gaseous fuels. Wood based fuels which are harvested renewably will have a reduced net carbon emission, as carbon is absorbed by the replacement trees. However, it has been shown that if wood fuels, even from a renewable source, are used inefficiently, they will emit products of incomplete combustion which have high global warming effect. Recent studies have shown that biogas, using renewable biomass, has the least impact of fuels on global warming. This is because it is the biofuel with highest efficiency conversion. Keys to reducing global warming impact are high efficiency of energy conversion, preferred use of renewable resources and increased efficiency of energy use.

The most immediate environmental concern which affects urban (and rural) households is a poor indoor environment. From an energy point of view this means smoke emissions in the kitchen. The World Health Organisation (WHO) has recognised that of the 12 million deaths in children under the age of five in the developing world, 3 million are caused by acute respiratory infections (ARI) alone, attributable to air pollution. In addition there are a number of other health impacts associated with smoke, such as eye disease, lung cancer and low birth weight. Inefficient combustion of fuelwood on a traditional indoor fire is the main cause of smoky indoor environments. Reduction of smoke through use of improved stoves or removal of smoke from the houses through chimneys and ventilation are the initial measure for combating these problems. Moving to higher grade fuels has been shown to have a positive impact on health. While less of a smoke risk, coal and charcoal, if poorly burned, can emit highly toxic levels of carbon monoxide, so should only be used in a well ventilated environment. There are also concerns associated with kerosene, LPG and electricity, mainly related to fire risks. None-the-less, smoke is the greatest health concern in the poorest households.

Recommendations for improving health and environment for people at all stages on the fuel ladder:

- *Reduction and removal of smoke from kitchens in households which are dependent on biofuels is essential for basic human health.*
- *High efficiency of combustion for all fuels.*
- *High efficiency of end-use.*
- *Aim for renewable use of biofuel.*
- *Aim to move from solid fuels to gaseous fuels.*
- *Aim to move towards non-smoke emitting renewable energy sources.*

5.3 Small Enterprises

As with many other aspects of the urban sector in developing countries, the energy inputs of small enterprises has not been studied quantitatively. Enterprises with the most direct relevance to the poor are the cooking and selling of food, small scale manufacturing and trading enterprises.

Street foods are an important source of economical and nutritious food, particularly for the urban poor. This sector is relevant to this study for two reasons: firstly, much of the energy used by the urban poor, in this case indirectly, is consumed by street vendors, and secondly, the health of the urban poor is consequently affected when food prepared in this way is contaminated due to the lack of a constant, sufficient heat source. One of the major contributors to bacterial contamination is the cooking of foods that are supposed to be served hot, but are made up in advance and stored for long periods of time before being served. When served, they are often not reheated to a sufficient temperature to kill the harmful bacteria. The Food and Agricultural Organisation of the United Nations (FAO) suggest that several cited food poisoning outbreaks in cities of the developing world, often leading to fatalities, could be traced back to the consumption of street foods. There is a 'lack of infrastructure at the local level to provide assurances that street foods were safe and of good quality'. This was due to a number of factors that included the lack of official recognition of this very large segment of the informal sector. The same can be said of the energy inputs into the processes of processing and preparing street foods.

Urbanisation has resulted in a proliferation of street food vendors and hawkers as the movement of people from rural to urban areas has led to the need to feed large numbers of working people away from their place of residence. In many countries, street vendors prepare the first meal of the day for low-income workers. In Thailand, for example, 20% of households eat most or all of their meals outside or bring the cooked food home.

In Kenya, the main fuel used by the urban poor in small enterprises is charcoal, which is used for smelting, welding and baking, although street food sellers also use saw dust and wood and kerosene. The larger and more formal the enterprise, the more likely it is that electricity will be used. Electricity is the preferred energy source, although it is not easily accessible to small enterprises. Many of the fixed enterprises are located in informal settlements that are viewed as illegal by the electricity utility. A general problem for those who use fossil fuels is the problem of consistency in the quantity and quality of the supply. The South African enterprises in which the poor are most likely to be involved in are cooking and selling food. As electricity is expensive, poor communities mainly use fuelwood for energy intensive income generating activities. Improving access to energy services for the poor is only a recent priority and has concentrated on electrification. This may not be sufficient by itself. Securing fuelwood supplies in urban areas is important for the poorest. In Peru, high electricity prices as a result of the removal of subsidies are a major constraint on the development of small entrepreneurs.

Recommendations*:*

- *Energy provision to small fixed enterprises needs to be made easier, since this is the sector that is most likely to provide employment opportunities for the poor. This necessitates recognising presently illegal structures as suitable for a fixed power supply.*

- *The use of wood by enterprises needs further investigation with a view to improving the supply.*
- *Information gaps need to be filled to ascertain the nature and quantity of fuel used by street vendors.*

- *The street food sector should be officially recognised as one that plays a vital role in the urban economy and specifically as a major consumer of energy.*

- *Credit should be made available to street vendors specifically for investing in energy efficient appliances.*

- *Education programmes into the safety aspects of uncooked foods should be developed.*

5.4 Access to Energy for the Poorest

It should come as no surprise that access to energy for the poorest in urban areas is restricted because of their poverty. Biomass fuels are more expensive per unit of useful energy used, but are the easiest and often only fuel available to the poor. It is not a universal truth to state that the urban poor never have good access to most forms of energy service; in India some slums are totally electrified. But the poor are the most the likely of any section of society to suffer from inadequate supplies and price fluctuations. Generally, their predicament is a combination of all or some of the following factors:

- Large distances to and from biomass fuel supplies. It is more difficult for those living in urban areas to collect, for free, fuelwood and crop residues;
- Inability to afford sufficient quantity or quality of 'commercial' fuels or electricity. In reality, fuels that are termed 'traditional' in rural areas acquire some monetary value in urban areas, so this term can apply to the whole range of available energy options;
- Inability to afford energy appliances. In places where fossil fuels are subsidised and are available to the poorest, the associated cost of appliances may prohibit their use. Where there is an electrical connection electricity may only be used for lighting: its use for cooking or heating may be difficult due to high additional appliance cost;
- 'Temporary' structures. Connecting slum settlements to the grid is a way of recognising and formalising their existence. Often, safety reasons are used to justify the electrical utility's unwillingness to connect to such settlements. In reality, illegal connections are commonplace and contribute substantially to electricity 'leakage' written off by the utility; legal connections would improve safety and provide an additional revenue stream for the utility. In the case of South Africa, the political commitment to mass electrification has shown in practice that innovative technologies can overcome most safety issues.
- Theft of appliances can also be a problem in insecure dwellings. This factor discourages households from acquiring new appliances.
- New technologies do not reach the lowest-income groups. While they may contribute to energy options in general, their price prohibits their use by the poor.
- Small enterprises often use energy more intensively than households and are subsequently affected to a larger extent by shortages and price fluctuations.

Strategies to improve the situation described above should form part of larger poverty alleviation programmes. The case studies and literature suggest that the following may be appropriate actions to take:

- *The definition of properties eligible for an electricity connection should be flexible enough to accommodate most structures in which the poor live.*

- *Renewable energy technologies should be designed with the poor in mind.*

- *Energy efficient appliances should be encouraged, maybe using fiscal measures.*

- *Credit programmes linked to the purchase of efficient appliances should be considered.*

- *Improve access to energy by using adapted equipment - in many cases the cost of electricity is less with new appliances than with older ones using kerosene or biomass fuels.*

- *Improvements in the supply, distribution and marketing systems for kerosene are one obvious policy need.*

6. INTERNATIONAL CASE STUDIES

The outcome of this study, which includes case studies from India, Kenya, South Africa, Peru and Mali, would help various government and funding agencies to understand these issues and promote a more sustainable and acceptable solution to problems of energy provisions in urban areas. Brief summaries of the main points from these case studies are presented here.

6.1 Kenya country study

The Kenya country study was conducted in several areas in Nairobi, which traditionally are inhabited by the urban poor. The case studies from Kenya addressed the following two themes: energy for small-scale enterprise and cooking fuels and technologies.

Charcoal is the main fuel used by *small enterprises* in poor urban areas. It is used for smelting, welding, baking and casting and forging metals. Firewood is second in importance followed by kerosene. However, there is a tendency to use more efficient fuels when the income of small enterprises increases

With respect to energy provision, charcoal supply is fairly reliable except during the rainy season where prices are inflated. Charcoal production is low during the rainy season and the roads where it is transported are impassable. All these extra costs traders are passed on to the consumer. Fuelwood is obtained from the nearby forest and of-cuts from furniture workshops. Although electricity is mentioned as the preferred fuel for most of the people, it is not highly easily accessible to the small enterprises. The reasons are more legal than financial since the enterprises are very often located in informal settlements.

Although kerosene and welding gases, acetylene and oxygen, are available, energy supply is facing several constraints. A key constraint is the monopoly of the distribution by the company that supplies welding gases. One has to register with the company and pay a monthly fee even if cylinders are not filled-up, as is common practice in industrialised countries. These requirements increase dramatically the costs. Heath problems associated with the utilisation of the various fuels are not listed as a priority although there is a concern about their impact. This might be due to the priority given to energy access at affordable prices.

Charcoal is the main cooking fuel used by *households* in urban poor areas. It is followed by kerosene and firewood. A notable aspect is the fact that every home that had a charcoal stove also possessed kerosene stove. Kerosene stoves are used mostly in the morning for preparing breakfast while charcoal stoves or open fire for firewood are used during the day for cooking or warming the food.

The utilisation electricity is almost non existent and gas is a very unpopular fuel for many poor urban dwellers apparently because of the damage that fire can cause to informal structures. However further analysis revealed that cost is the main reason for not using gas. Apart from the lack of income, which is in itself a hindrance to the provision of energy, the absence of property rights limits dramatically energy access for poor urban people. The fact that they live in the informal settlements makes it difficult for them to access to electricity or to use LPG safely as risk of fires is great.

Improving energy access to the urban poor implies action on these key constraints, particularly geared towards small enterprises who are currently the main source of employment for the urban poor. Innovative ways of providing credit to small enterprises could greatly improve their access to sustainable energy supplies. The formal recognition of small and medium enterprise (SME) by the utility (Kenya Power and Lighting) should facilitate their access to a better service. This could be done by licensing them in groups in the areas where they are operating.

6.2 Mali country study

One indicator of urban poverty in Mali and Africa is lack of ownership or access to urban land. Droughts and political upheaval, which have hit Mali severely in 1984 and 1992, have led to increased migration from the rural areas. In Bamako, the peripheral and most recently settled areas are those least electrified and the poorer urban population is concentrated in these areas.

In Mali, the household energy sector is characterised by the predominance of wood as major cooking and heating fuel. The consumption of butane is still low, despite a subsidy to the producers since 1992. Malian urban households operate under severe budget constraints, which limit their energy choice to the cheapest forms of energy, wood and charcoal, which are not necessarily the most cost-effective.

For Bamako, a representative sample shows that 63.5% of the households do not have electricity in their home. Outside Bamako, there are only six towns with regular electricity supply from the grid.

Two major actions might be considered to improve energy access for the urban poor. At the *supply level*, Energy Master Plans for Bamako, the major cities of the south, and cities of the north should be drawn up, taking into consideration the major supply options (charcoal, electricity, gas, kerosene) and put the emphasis on households and small-scale enterprises. For example, selected towns of the north could be solely supplied by boats from dead wood around Lake Debo, without touching on the few remaining forest reserves. On the other hand, for the south, where higher rainfall prevails, fuelwood plantations and efficient protection of forest reserves seem to be the preferable options.

From the *demand side management*, consumer awareness campaigns for improved wood and charcoal equipment should be continued, however with specific messages to women and men and with concrete figures on subsidies and monetary savings. Publicity campaigns, to be conducted via local FM stations and national TV, should focus their messages more on monetary aspects rather than ecological advantages.
Payment schemes by instalments could be introduced for the acquisition of gas stoves and cylinders. Filling stations, which proved to be a success in some neighbouring countries, could be considered. This approach avoids the need for handling and transport. Once acquired the bottle is always available and the customer does not need to cope with a shortage of bottles and waiting time.

Budget constraints and lack of concrete information about potential savings are among the major factors responsible for the slow adoption of energy-saving equipment. Absence of any form of consumer credit e.g. possibility of payment in instalments, also restricts the greater dissemination of energy conservation equipment in households and the informal artisan and processing sectors.

6.3 South Africa country case study

South Africa has a relatively strong industrial base and has adequate fossil and biomass resources. Therefore access to energy in South Africa is not so much a resource problem as a challenge of redistribution of these resources so that all may have access to them. This is a key national issue which requires considerable political will to address.

In South Africa, the provision of energy services to urban low-income households is a new initiative at the macro-level. The main strategy for this has been the mass electrification programme, which has been partially successful. The entire programme is massively subsidised by Eskom, which is a parastatal utility, so customers pay only a nominal to be connected. This accelerated programme was planned to last until 2000, after which it will slow down. Electrification is limited to those households which have legal tenure, something which excludes many informal houses in urban areas. Thirty per cent of urban dwellers are without electricity, and even those who are connected continue to use a combination of energy carriers including electricity, LPG, paraffin and wood.

The relative success of pre-payment meters in meeting the payment requirements of suppliers. From the customer's point of view, pre-payment technology enables the purchase of electricity in small denominations to suit unpredictable incomes, and the ability to monitor energy use and adjust appliance use accordingly. The disadvantages of the pre-payment system are that are that they are packaged with a ready-board with one light and three plug sockets which may be dangerously overloaded and extended by 'street electricians'. One light fitting is not sufficient for the whole dwelling and so people are still using paraffin and candles with the accompanying health and safety hazards. Pre-payment technology is locally developed and is constantly being improved.

Alternative forms of energy provision have received growing attention and interest. Because of the need to reduce poor people's spending on thermal applications and reduce health and environmental costs, as well dealing with peak loads, three projects which attempt this are reported: two solar water system projects in Ivory Park and Lwandle, and a low-cost housing scheme which used passive solar designs and insulated building materials. These projects demonstrate the general problems associated with solar/PV projects in South Africa to date. Solar and PV technology is still relatively expensive in South Africa and has achieved limited success. It is not subsidised, so each project has to attract funding, usually international, and cannot always be replicated.

Other problems include that the fact that hot water metering and monitoring prototypes will not provide an adequate cost recovery, and the combinations of technologies being tested for the first time, solar water heaters (SWHs) and thermostatically controlled LPG-in-line water heaters, will not be as compatible as they appear theoretically. The small businesses to be set up around the provision of affordable hot water services have yet to prove themselves. The lessons learnt from participative projects are the slowness of the process where many stakeholders are involved, and the crisis engendered by a single withdrawal. The Kutlwanong project was the most successful, but it also demonstrated that building energy-efficient houses is a slow process requiring negotiations with different stakeholders. In addition it is important for developers to learn from each other's experiences.

The cost-savings associated with the solar water heaters are only an advantage in houses which have pressurised water. It is important that back-up systems work efficiently in the cold, wet winters of the Western Cape, otherwise solar technology gets a bad name for not meeting needs. In the three projects, barriers to implementing energy efficiency technologies generally relate to high entry costs, lack of awareness about possibilities, and the need for community commitment.

The South African study also focused on small-scale enterprise. Selling food is one of the most widespread small-scale enterprises and it requires considerable energy input. Indications are that electricity is too expensive for the heating required for the preparation and cooking of many foodstuffs (for example sheep heads) so wood is used instead. The social barrier to wood use in urban areas falls away when it is used for income generating activities. That is to say, households that avoid using wood for domestic purposes (meals, making tea) because they do not want to be regarded as (very) poor or rural, have few qualms when it comes to using wood for brewing beer or cooking chickens or sheep's heads. There is however a need to have a better understanding of the movement and uses of quantities of wood before solutions can be found. Policy recommendations for open space provision in urban

areas, which include urban woodlots, are currently on the table, but whether these will be implemented and supply the wood required remains to be seen.

The South African case gives a good example of the labour and energy-intensive activities where many women engage in for uncertain profit. Primary inputs into the products of the woman in this study are labour, the ingredients, wood and transport. Any change in any in the inputs, such as cutbacks in the number of trains, may upset the balance and render the enterprise unviable.

Another case documents the attempt of a group of informal traders, an NGO and six major funders (national and international) to provide appropriate facilities for informal traders to sell their wares with an emphasis on empowerment, skills training and the integration of hostel dwellers into the broader community (Mqela 1997). The need to provide appropriate facilities for the meat market was perhaps the primary driver, but the market is big enough for 110 traders for all types. Wood plays an important role in the meat market – it is used for cooking fires on the spot and social fires for beer drinkers in winter. A trade in wood has been observed, but no attempt has been made as yet to quantify or qualify this.

The case study contains one of the few documented examples of a small-scale enterprise which involves wood collection and selling. As with the commercialisation of many activities, wood collection in this case becomes men's work. Again the enterprise is a fragile one – there is not sufficient profit in the business.

What the case studies on small-scale enterprise demonstrate is the precarious nature of these activities. Any intervention which upsets the dynamics or balance of inputs which are currently functional, however well intentioned, may render the activity no longer viable. It is not always clear from our studies whether there is a profit from micro-enterprises and how much it is, or whether turnover is what keeps activity alive. Although the profitability of many small-scale enterprises is dubious, they serve personal and social purposes beyond profit making. Ways of securing current energy use patterns may be more useful than attempting to change them. Perhaps only when large numbers of poor people are secure can transitions to 'higher grade' energy sources or rented space or skills training is secured too.

6.4 India case study

With the fast pace of economic development in the country, India has emerged as a nation with one of the largest urban population in the world. About 217.6 million of the Indian population live in urban agglomerates and towns. The urban population in India constitutes 26% of its total population and is increasing at the rate of 3% per annum. More recent estimates by the World Bank show that 36% of the Indian population is under the poverty line. Of them 76 million people constitute the urban poor in India accounting for 36% of the urban population

With respect to energy, household consumption was positively correlated with income, for both rural and urban areas. The urban poor still depend quite substantially on traditional fuels, such as firewood and dung-cake to fulfil their energy needs. The price of firewood has increased dramatically in the last ten years. Thus the poor pay a much higher price per equivalent unit of energy than the rich.

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

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

Among the households surveyed for this study, kerosene emerged as the most popular source of energy, mostly used for cooking purposes, and also for lighting purposes in case of power cuts. Fuelwood, sawdust, dung cake and sometimes coal were used as supplementary sources of energy for both cooking and heating purposes. Though electricity was available in all the clusters visited, households did not have legal connections, and was merely hooking on to street lighting connections or through generator sets. Hooking is a common practise in areas where households do not have legal electricity supply.

89% of the total households used kerosene, either as the only source, or in combination with supplementary sources of wood, cow-dung, or LPG, for cooking purposes. Hence kerosene was used for lighting purposes only during the very frequent power cuts. Commonly used gadgets for lighting are earthen lamps or *diyas*, lanterns, wick lamps etc. The popularity of kerosene for cooking purposes cuts across the income.

Wood emerged as the next popular source of cooking, and heating. Approximately 53% of the households used wood either as the only source or as a supplementary source for cooking and heating. Most of the times, fuel wood was collected from nearby green belts, or from forests in the Delhi Ridge areas, though at the risk of being caught and fined.

LPG usage is limited among the urban poor, with only 10% of the household having LPG connections. This was largely because the difficulty in getting a LPG connection, and the substantial initial deposit.

All the households had access to electricity, even though none of them had legal electricity connections. As none of the houses had meters provided by the Government, no one received any bills for the use of electricity. However most households were willing to pay more, if that ensures them a regular, and legal electricity supply. This was evident by the fact that 41% of respondents had deposited Rs 360 with the Delhi Electricity Supply Undertaking (DESU) to get a meter installed in their homes.

Although several Renewable Energy (RE) technologies such as Wind, Micro- hydro have been proven to be commercially viable in niche application sectors, Bio-energy has not yet been demonstrated at a commercially meaningful scale. DESI Power Orchha project is the first attempt at utilising local bio-energy resource for electrification using a model which is commercially viable and environmentally sustainable. DESI Power is currently concentrating on biomass gasifier technology which uses non-forestry weeds or agricultural residue as feedstock. In this technology, biomass is burnt in a partial supply of oxygen to generate a combustible gas called producer gas, which is mostly a mixture of carbon monoxide and hydrogen. The engine is connected to a generator that produces electricity. The

waste heat from the engine can be used as process heat for drying, heating, or boiling, or for running air-conditioning or cold storage plants. At TARAGram, a local weed called Ipomea is used as the feedstock. A strong prerequisite for pushing new technologies from demonstration to commercialisation stage has been their attainment of commercial maturity. Strong RD&D, sound industrial support, ability to provide quality of services, and reliable field performance in terms of operability and maintainability are a few factors defining commercial maturity of a technology.
Currently, the plant profitability is poor

6.5 Peru country case study

Peru is a country characterised by great contrasts and marked social differences and Lima, its capital, is the main representative of this characteristic. In this city there are many impoverished urban zones which have grown exponentially in the past few years.

Poverty is defined as a situation in which a family's income is not sufficient to purchase a basic set of goods and services (which defines a pattern of consumption that reflects an average welfare). For the period between 1991 and 1994, the number of poor people in Peru decreased from 57.4 to 53.4 percent of the total population and between 1994 and 1997 this percentage decreased even more to 50.7 percent. In absolute terms it is estimated that between 1994 and 1997 the number of poor people in country decreased from 12.32 to 12.16 million.

The poorest people segment is known as "extreme poverty" or "indigence" and it is basically the population whose income does not allow them to buy a basic group of staple foods necessary to cover the minimum nutritional requirements. For the 1994-1997 period, the number of people in indigence decreased from 19 to 14.7 percent of the total population. In Lima, the levels of evolution are far more favourable because in 1997 extreme poverty only affected 2.4 percent of the population after reaching its peak in 1991 at 10.1 percent.

With respect to energy for lighting in the province of Lima, a large number (62%) used electricity, about 29% uses kerosene or petroleum, about 7.3% uses candles, about 0.8% has no lighting and less than 0.6% uses other forms. For cooking fuel less than 0.7% uses electricity, about 15% use LPG, about 32% use kerosene, 0.7% use coal, about 44.4% use wood, 6.3% use other fuels and only 0.2% do not cook.

In metropolitan Lima for lighting families use electricity, kerosene or petroleum, and candlelight. As a fuel for cooking some use electricity, gas kerosene, coal, wood, others or they do not cook.

With respect to energy choices, the survey revealed that the majority would not use another fuel other than gas and kerosene because of the convenience of these fuels. Many of gas consumers would return to kerosene if and only if the price of LPG increased dramatically. The main reason why some families still use kerosene is because their income does not allow them to purchase LPG. Household income is by far the greatest limiting factor for access to energy in Lima.

To increase energy access for the urban poor, four key recommendations might be considered:

a) In terms of policy:

- Define the energy supply situation for people without access.
- Define a pricing and tax policies.
- Monitoring the progress in extending supply energy services.

b) In terms of price energy:

- Avoid uniform national pricing policies.
- Support incentives for sustainable access.

c) In terms of finance:

- Define transparent subsidies since the project's beginning.
- Avoid subsidies without its respective financial support.

d) In terms of institutions involved:

- Encourage local initiatives and projects, in order to support creation of small energy services enterprises.
- Encourage initiatives to use renewable energies in peri-urban areas
- Strong monitoring of government agencies involved in programmes and projects.
- Strong technical supervision of projects: money spent in supervision now is money saved tomorrow in spare parts and costly equipment reparations.

7. CONCLUSIONS

Access to energy for the urban poor is a complex issue, which is very specific to the individual context. Each city has quite unique access problems, and each household will make decisions based on their own economic and practical situation. However, there are common themes which can be drawn from the study presented here. Some of the key issues which have come out of this study are presented below.

Cities in transition
Cities in developing countries are at different stages of transition to modern energy sources (fossil fuels and electricity). The rate of transition from traditional biomass fuels to modern energy sources will depend on two main factors: economic conditions of the poor in the city and relative availability of and access to the various fuels.

Rural/urban links
All cities in developing countries, but particularly those cities which are in the earlier stages of transition to modern fuels, will have a close relationship with the surrounding rural areas. Changes in city energy consumption patterns will have a significant impact on rural livelihood, as many rural people depend on supplying wood and charcoal to urban centres. Any policy which aims at changes in the energy supply system, must also consider the impacts in rural areas.

Access for the very Poor
Not surprisingly, the poorest in any urban community will have the greatest difficulties in accessing higher grade fuels. It is often the case that the poorest pay the highest price for useful energy. This is because they are dependent on low grade fuels which convert to useful energy at very low efficiencies. The result of burning low grade fuels in poor quality houses is a very smoky indoor environment, which has very significant impact on the health of the households, particularly children. There is urgent need to use economic or policy means to assist the poorest to access higher efficiency equipment and to encourage the transition to higher grade fuels.

Small enterprise
The urban poor are largely dependent on small scale enterprise for income. Street food vendors are a common site in slums, where there is a trend towards buy cooked food rather than to cook at home. Small scale manufacturing and repair services are also common enterprises. Such businesses are usually very vulnerable to changes in economic climate. This includes changes in access to energy supplies. To have a positive impact on the poor it will be essential to improve access for small enterprise to energy efficient equipment and adequate fuel supplies. Access to electricity to informal settlements has been identified as an important measure for improving energy supplies for small enterprise.

Policy
National and local policy has a very important role in shaping the energy supply market in the cities. Through taxes, subsidies and regulations, policy can achieve dramatic changes in the market. While policy aimed at one sector of the market may be very effective, it is possible that it will have negative impacts on others. Poorly implemented fuel subsidies may help the better off who can afford the transition to new fuel technologies, and disadvantage the poorest access the subsidised fuel or who depend on selling fuel wood for a living. Not allowing grid connections to informal settlements prevents households and businesses from accessing electricity, even where there is willingness to pay. Therefore, while policies can have a very positive effect, there must be care not to disadvantage vulnerable groups.

Financing options
Access to suitable financing is a recurring theme through out this issues paper. For all levels of the community to move to higher grade fuels, it is essential that appropriate financing is available. Finance is required for up front costs such as of equipment purchase and also for spreading costs of fuel purchase. One example is the use of innovative technologies which are now available to replace standard electric metres and to make electricity payment easier for poorer households.

New Technologies

Renewable energies and energy efficiency technologies are making a gradual impact on poor urban communities. Solar power (thermal and photovoltaic), biofuels and thermal insulation of houses are just a few examples of new technologies being introduced in poor urban areas. Small scale waste to energy technologies are very new, but have a significant potential for future energy needs. Difficulties in applying these technologies include: current high cost, lack of knowledge in the communities about the technologies and need for appropriate institutional and financing structures.