Energy and the Urban Poor

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Introduction

For two main reasons, the urban poor of developing countries deserve much closer attention and concern than they normally receive from energy policies.

The first reason stems from basic issues of welfare and distributional justice. Adequate fuels for cooking and lighting (and in some cities, space heating) are as essential to survival and modest improvements in living standards as adequate food, clothing and shelter. Yet the urban poor often find it difficult to obtain sufficient fuel to meet their low levels of energy use and the services this provides. Their heavy dependence on firewood (and other biomass fuels) means that they use the most inefficient, inconvenient and, very often, the costliest energy sources. Their share of income spent on energy is normally much greater than that of middle and upper income groups. And their fuel supplies are often precarious, since they lack the safety net of the rural poor, who can usually find firewood to gather, even if illegally, and who can turn to crop residues and animal dung if firewood supplies fail.

In every important respect — the quantity and quality of energy use, security of supply, fuel costs and budget shares, and sensitivity to rising fuel prices — the urban poor are therefore at the very bottom of the energy ladder. But more than this, the disparities between the poor and others are usually greater in cities than the countryside. In rural areas both rich and poor tend to use similar kinds of fuel and amounts per capita because, in each location, everyone faces much the same restrictions on supplies of modern (or 'commercial', 'non-traditional') energy sources such as kerosene, bottled gas and electricity.

The second reason for focusing energy policy on the urban poor stems from their dependence on woodfuels. In many Third World countries the rings and patches of deforestation around major urban centres are at least in part caused by cutting for firewood or charcoal to meet growing urban demand. This spreading deforestation not only raises urban woodfuel prices through increased transport costs and supply scarcity: it may also have severe impacts on rural fuel supplies and tree resources, with attendant problems of soil erosion and lowered biomass productivity.

In particular, as the pressures from urban commercial wood markets spread outwards, rural firewood supplies become monetised. As firewood is commoditised, access to traditional 'free' sources is often reduced for the landless, small farmers and others who cannot grow sufficient fuels for their own use; or customary traditions which protect forests and woodlands from over-exploitation break down. Although these pressures may bring positive changes — for example, encouraging tree planting for urban markets, providing employment for small and large wood traders, and adding an extra source of farm income — their effects are generally negative and sharply regressive.

This article reviews a range of energy policies aimed at improving the welfare of the urban poor and reducing the pressures they exert on wood resources. But before we examine these we need to look at typical patterns of urban household energy according to income and other key variables and, in particular, at various 'poverty traps' which prevent the urban poor from moving out of woodfuel dependence and otherwise improving ther energy-related standards of living.

Energy-Income Trends

In almost every city for which household energy surveys exist there is a roughly similar progression, as incomes rise, in the types of fuel and equipment that are used. For the major energy uses — cooking and other forms of heating — the progression is: any burnable scraps of wood, sticks, leaves and paper, etc., using an open fire; firewood and an open fire; firewood and an enclosed stove; charcoal stove; kerosene; bottled gas (or natural gas if available); and electricity. In some areas, such as parts of Northern India, coal and coke are widely used by the poor and middle income groups. In many parts of Africa and Latin America, charcoal is preferred to firewood and kerosene and even displaces gas and electricity at the highest income levels. This is partly a matter of taste, but also of convenience: charcoal, like all the modern cooking fuels, is easier to carry and store and less smoky than firewood.

With lighting, in many poor households the sole source is a feeble lamp in which a naked flame burns from a wick immersed in a bottle, jar or can of kerosene or vegetable oil. The light output is roughly

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equivalent to that of a small (2 Watt) electric torch. Other choices for the poorest are light from the 'cooking' fire, candles, or sparing use of an electric torch. From here the typical income progression is towards larger and brighter kerosene wick lamps with a glass chimney; kerosene hurricane and pressure lamps; and electric lighting. Although lighting uses relatively little energy, it has an important place in household energy behaviour and concerns because it is often the only energy service for which the poorest must buy fuels, while improved lighting is usually given a very high priority in the achievement of better living standards.

Once a household has electricity, the door is open to a multiplicity of widely desired devices such as irons, cooling fans, radio and TV, refrigeration, and — in the highest income brackets — air conditioning. Ownership of this equipment as well as the ability to pay for connection to electricity services is, of course, very strongly correlated to income.

Table 1 shows the income progressions for the proportions of households using the main cooking fuels in some large Third World cities. Although there are considerable inter-city variations, the broad trends are similar: notably the importance of firewood among the poor, the use of kerosene as a transitional fuel (often as a standby), and the rapid increase of gas and electricity in the upper income brackets. Because of multiple fuel use (especially of kerosene), these trends are even clearer if one considers the actual consumption of each fuel. Table 2 gives an example based on the average urban pattern in India in 1984 [Natarajan 1986].

Obviously, these fuel choices and substitutions are strongly driven by desires for greater convenience, quality of service or energy 'output', and cleanliness. The progressions also lead to time savings in obtaining and using fuels, often a crucial factor for the poor. In a city, firewood must either be scavenged or fetched

Table 1

Cooking fuels by income in urban households (per cent of households using each fuel)

	Firewood	*Charcoal*	*Kerosene*	*LPG*	*Electricity*
Kuala Lumpur (1980)					
Low income	4	15	75	25	19
Middle income	7	23	57	52	35
High income	0	17	19	87	50
Manila (1979)					
Low income	9	1	35	45	11
Middle income	2	1	5	73	19
High income	1	0	1	78	19
Hyderabad, India (1982)					
Low income	41	small	70	19	(a)
Middle income	24	small	65	4	(a)
High income	13	small	57	71	(a)
Bombay (1972)*					
Low income	24	17	96	7	(a)
Middle income	1	11	76	80	(a)
High income	0	6	54	100	(a)
Lae, Papua New Guinea (1978)					
Low income	79	—	21	—	—
Middle income	41	—	42	—	7
High income	1	—	6	7	90

* Kerosene includes lighting uses, LPG includes piped gas derived from coal

(a) Not measured for cooking

Sources: Kuala Lumpur [Sathaye and Meyers 1985]; Manila [PME 1982]; Hyderabad [Alam et al. 1983]; Bombay [NCAER 1975]; Lae [Newcombe 1980]

Table 2 **Fuel shares for cooking and heating by income: average urban households, India 1984 (per cent)**

Income level:	*L*	*LM*	*M*	*HM*	*H*	*ALL*
Firewood	53.5	30.8	17.9	9.9	9.6	27.4
Soft coke	6.4	18.0	17.9	15.2	8.3	15.3
Kerosene	23.8	36.9	40.2	38.2	32.8	35.7
Bottle gas	1.2	4.6	15.7	27.9	39.3	11.5
Other	15.2	9.7	8.3	8.8	10.1	10.1
(% households)	(17.6)	(33.6)	(35.1)	(9.4)	(4.3)	(100)

Incomes: thousand Rupees per year (Rs. 1978-79)
L = Low (under 3); LM = Low-middle (3-6); M = Middle (6-12); HM = High-middle (12-18); H = High (over 18)
Source: Natarajan [1986]

from a shop, and a cooking fire needs tending. At the other extreme, gas and electricity are delivered to the dwelling and cookers often have automatic time controls.

The extent of these fuel and equipment substitutions and the income levels at which they take place are obviously critical parameters for energy policy. But as Table 1 suggests, they differ considerably from place to place since they depend on the relative prices and availability both of fuels and the equipment for using them, and hence on factors such as the reach and reliability of modern fuel and power distribution systems, equipment manufacturing capabilities, and average incomes.

Generally, within a country, these factors are captured by urban size. In India, for example, 75 per cent of energy for cooking came from modern fuels in 1979 in cities of over 500,000 population, while only 38 per cent did so in towns of under 50,000 population [Natarajan 1985; Leach 1986]. The equivalent figures for kerosene were 29 per cent and 10 per cent and for bottled gas (LPG) 16 per cent and 3 per cent. These differences were also reflected, but to a lesser extent, in the fuel shares of the lowest income groups.

This urban size effect points to some important policy implications, as do the extreme cases that one also finds. At one extreme, in many African cities petroleum cooking fuels are now almost unobtainable, as in Dar es Salaam, Tanzania [Skutsch 1986]. In Luanda, Angola, the manufacture of kerosene, gas and electric stoves and lamps has collapsed, as have kerosene and LPG deliveries to the household market [Marleyn 1986a]. In these cases, basic economic difficulties have effectively cut off the energy ladder above the level of woodfuels, to which most families are forced to revert. At the opposite extreme, in central Dhaka, Bangladesh, a remarkable 40 per cent of low income families cook with natural gas because it is widely distributed, its cost is limited to a fixed monthly charge, and illegal connections are common [Giri et al. 1986].

Efficiency trends

No less importantly, the typical series of income-driven fuel and equipment substitutions is a progression towards very greatly increased energy efficiency. This effect reduces — or more than offsets — the tendency for fuel prices to increase across the woodfuel-petroleum-electricity range. As a result, one frequently finds that the poor use the most expensive fuels when these are priced on the basis of useful energy; e.g. heat supplied to the cooking pot.

Although efficiencies vary considerably depending on the type of equipment and how it is used, reasonable rule of thumb figures for cooking are: wood open fire with clay pots 5-10 per cent, with aluminium pots 12-15 per cent, metal wood stoves 20-30 per cent, charcoal stoves 15-35 per cent, multiple wick kerosene stoves 25-45 per cent, kerosene pressures stoves 25-55 per cent, gas 40-60 per cent, and electricity 55-75 per cent [World Bank 1986]. Note that for the options that could reasonably be available to the poor today or through targeted energy policy initiatives — namely, up to and including the kerosene pressure stove — efficiencies improve by a factor of about five.

For lighting, a kerosene pressure lamp is about 12 times more efficient than a simple wick lamp, and an electric incandescent bulb is about 10 times more efficient again — an overall range of around 120:1 [World Bank 1986].

Table 3 illustrates the common urban phenomenon of a falling price for useful heat energy as one moves from the inefficient woodfuels and equipment used

Table 3 | **Comparative prices of urban cooking fuels in Nigeria**

Fuel	Purchase Price (k/unit)	Energy Content (MJ/unit)	End use Efficiency (%)	Effective Price (k/MJ useful heat)
Firewood (kg)	17	15	8-13	8.7-14.2
Charcoal (kg)	22	25	20-25	3.5- 4.4
Kerosene (1)	10	35	30-40	0.7- 1.0
LPG (kg)	34	48	45-55	1.3- 1.6
Electricity (kWh)	6	3.6	60-70	2.4- 2.8

k = kobo
Source: adapted from [UNDP/World Bank 1983]

Table 4 | **Energy performance and illustrative costs of lighting equipment**

Fuel and Lamp Type	Light Output*	Fuel Consumption Index**	Cost (Indian Rupees)***
Kerosene			
Wick lamp	0.5	130	1.0- 2.5
Chimney lamp	1.5	50	3.5-28.0
Hurricane lamp	3.0	25	17.5-28.0
Pressure lamp	30	10	(high)
Electricity			
60-W bulb	40	1	4.0- 5.0 (a)

* Foot candles at 30 centimetres from lamp
** Rate of energy consumption (e.g. litres/hour, watts) normalised to one for the electric bulb
*** For Lucknow, India, 1985. Daily income for labourer households averaged Rs 14.3 (Rs 3.4 per capita)
(a) excluding connection charges, wiring, etc.

Sources: light output and consumption [World Bank 1986]; costs [Sharma and Bhatia 1986].

predominantly by the poor to those of the rich. Table 4 presents some data on the light output, efficiency and cost of lighting equipment which underscore the remarkable differences in the performance of technologies used by the poor and higher income families.

Again, one must be a little wary of generalisations. Although Table 3 illustrates the usual trend for cities with high priced wood and subsidised modern fuels, the trend is sometimes reversed. For example, in Colombo, Sri Lanka, in 1984 kerosene was about 50 per cent more expensive than firewood on a useful heat basis [Leach 1986]. Strong fuel preferences may also upset the trend. In the town of Waterloo, Sierra Leone, the average family was found to spend 30 per cent of its income on firewood and cheaper fuels were available, but two thirds of families would not switch from wood 'for any reasons whatever' [Cline-Cole 1981]. Reasons for preferring firewood included food tastes, safety and the wider range of cooking methods (e.g. grilling) that are possible. Costs compared with petroleum fuels seemed to be the least important consideration.

Energy budget shares

A major consequence of these typical fuel use and income trends is that the fraction of income or expenditure devoted to household energy (excluding private transport) decreases sharply across the income range. This appears to be an almost universal rule, due to the combination of improved energy efficiency with greater income and a low income elasticity of demand for useful heat. In plain language, the rich do not need significantly more useful heat for cooking than the poor, but cook much more efficiently with fuels that are not that much more expensive.

As shown in Table 5, this phenomenon is not confined to developing countries: in the early 1980s the urban poor in the USA and UK had some of the highest household energy budget shares ever recorded. But they also had a social security system, which is usually lacking in developing countries and which can, at least in theory, ameliorate the worst effects of fuel poverty. It is also worth noting that the budget shares of upper income families in the Third World are usually lower than in industrial countries because of the limited space heating demand (which *is* income elastic). Consequently, there is a greater disparity between poor and rich in developing countries compared to others in the sensitivity to fuel price increases and inherent interest in energy saving measures.

Table 5

Household budget shares for energy: urban areas (per cent of income spent on fuel and power, excluding personal transport)

	Lowest Income	*Highest Income*
USA 1982		
oil heating	31.9	3.6
average	20.0	2.7
UK 1982	11.9	4.3
Brazil 1979	19.0	0.9
Chile 1978	7.6	3.1
Dominican Republic	6.4	2.0
India:		
Pondicherry 1979	18.4	5.2
Hyderabad 1981*	10.7	1.5
Pakistan 1979	8.6	1.8
Sri Lanka 1981	9.7	3.2

Note: Gathered (non-commercial) fuels are included in expenditures using an imputed price. In cities this probably has little effect on actual cash expenditures and budget shares.

Source: [World Bank 1986]

Policy Options

A useful way of thinking about policy options for improving the energy systems of the urban poor is to consider the various obstacles which prevent the poor from improving the efficiency and utility or reducing the costs of their energy use. Obvious factors such as raising employment and incomes are not considered. Emphasis is also given to policies which are less often discussed in the literature.

The poorest of the poor

The destitute of the urban shanty towns and pavements face a range of intractable energy problems due mostly to physical or 'non market' factors. Usually they must scavenge for any scraps of burnable material — weeds, animal dung, sawdust, cardboard, twigs and brushwood, etc. — because there are few trees to provide gathered firewood, and commercial fuels are beyond their means.

Two things follow from this: First, the poorest must use inefficient open fires because they can accept any shape, size or form of fuel. Second, their supplies are precarious because they can be destroyed by slight changes to their environment or life styles, such as the loss of open land to buildings or the abandonment of small scale urban dairying. In some squatter settlements of Delhi, for example, there used to be adequate cowdung cakes, weeds and tree bark until the surrounding areas were built over. Today the slum dwellers buy kerosene for lighting and have to burn old tyres for warmth in winter [CSE 1985]. Urban growth and sprawl has a similar effect in many cities by reducing the amount of local plant material that can be gathered.

Urban planning which maintains or increases the 'green' areas of cities and their peri-urban fringes — whether as trees or interstitial farm or dairy land —has an important part to play here.

In other cases the poorest slum dwellers are forced to buy woodfuels because they have little time to collect firewood or dung, etc. They are also prevented from moving up to kerosene, even if this costs less, due to the nature of their dwellings and occupancy rights [CSE 1985]. None of their belongings is usually worth more than one US$ or so, and their housing is too inadequate to prevent the theft of valuable items such as a kerosene lamp or stove. Bulky possessions may have to be kept to a minimum in case the family has to move in search of work, or the settlement is cleared out by the city bureaucracy. Electric or piped gas supplies to slum areas are also frequently ruled out, amongst other reasons, because dwellings are too flimsy and unsafe to support wiring, pipes and fittings, etc.

It is hard to see what to do here short of encouraging community-based action and self-help schemes, or providing better standards and permanent accommodation. However, in both cases 'energy' will be only a minor driving force for these changes.

Woodfuel users

For the majority of the urban poor which depends on purchased woodfuels (see Tables 1 and 2) the main policy initiatives have aimed at improving the efficiency and other features of cooking stoves and increasing woodfuel supplies by tree planting schemes of various kinds. These topics are the subject of a vast literature based on a multitude of more or less successful schemes and will not be reviewed in any detail here. For cooking stoves the main lessons of experience have been that designs must match a wide range of user requirements apart from improved fuel efficiency; that these requirements are often location or class specific (there is no 'general' improved design); and that stove programmes must consider every part of the design and implementation chain from initial market research to the capabilities and economic environment of manufacturing and retailing. Tree planting for fuel is unlikely to succeed unless its benefits in relation to costs are demonstrably superior to those of all possible competing uses of land, labour and other inputs. This has rarely been the case.

Another major option is to reduce woodfuel prices by attempting to control woodfuel markets and the sometimes excessive profit-taking by middle men in the distribution chain. Some figures illustrating the scale of this problem, based on 1986 charcoal data for Luanda, Angola [Marleyn 1986a], are given below:

	Prices per kg (kwanza)
To producers	125
Transport	up to 40
By retailers	250- 375
By consumers	800-1200

Although costs incurred in these distribution stages are not known, comparisons with other countries suggest that large profits are being made, especially by retailers. As a further example, a survey of 218 firewood merchants in Bangladesh found differences between buying and selling prices ranging from 10 per cent to over 200 per cent: while half the traders had a 20-50 per cent difference, for a tenth the mark-up was 50-100 per cent and for another tenth it was over 100 per cent [Prior 1984].

Large profits are also made by selling wood in small quantities, a practice which hits particularly hard at the poor, who are forced by lack of cash and transport facilities to buy fuels in small amounts at a time. For instance, in Maputo, Mozambique, charcoal in early 1986 cost 60-120 metical per kilogram when bought in 40 kg sacks, but 335-670 metical/kg when bought in two litre (300 gram) tins [Marleyn 1986b].

Conventional market forces might be expected to reduce the worst of these excesses. However, the bulk urban woodfuel trade is often run by a few, powerful families while the smaller traders, who must reduce prices to stay in the game, can supply only a fraction of the market.

Local 'nationalisation' of the woodfuel trade or price fixing (as practised in many countries with petroleum fuels) are possible solutions, although they would not be easy to implement or — with price fixing — police. To compound these problems, the great variety of woodfuel prices, both absolutely and compared to alternative fuels, suggests that in many countries these measures would have to be implemented on a city by city basis.

Woodfuel prices can also be held down and supplies increased by more indirect means. One set of options is to promote fuel conservation and/or the use of modern fuels among commercial woodfuel consumers such as bakers, potters, beer makers and restaurants. In Hyderabad, India, bakeries alone account for close to eight per cent of total firewood use [Alam et al. 1983] while in most Third World cities the non-household sector probably uses something like 15-25 per cent of all woodfuels.

A second set of indirect policy options is to encourage the conversion of wastes produced by the 'biomass industries' (e.g. timber, furniture, packaging, food) to briquetted or other forms of compacted fuel. Since these materials are normally considered to be wastes, sometimes with a high disposal cost, and are produced close to fuel markets, their final price can often be lower than that of conventional woodfuels. However, their conversion may deny some fuel to the poorest collectors, and their use often requires special designs of cooking stove.

Modern fuels: availability and equipment costs

As outlined above, the move from traditional to modern fuels offers so many advantages in greater convenience and efficiency, often at lower cost, that most families make it once they are able to do so. A basic policy question is what prevents poorer families from taking this step. Policies to reduce these obstacles must be considered as major options for improving the energy situation of the urban poor.

With cooking the first modern fuel on the energy-income ladder, kerosene, involves the purchase of a kerosene stove. In their simpler forms these are quite cheap and well within the discretionary budgets of all but the very poorest. As a fairly typical illustration, a 1985 survey of labourer households in Lucknow, India, found that an iron kerosene stove cost Rs 15-60 (approx. US$ 1-4), or the equivalent of one to four days' households income (Rs 5235/year) [Sharma and Bhatia, 1986]. At prevailing prices, kerosene cooking costs only two fifths as much as using an open wood fire, the normal practice among these families: the payback time on investment in a kerosene stove was around one to four weeks. But very few families cooked by kerosene, not because they could not afford the stove but because the fuel was difficult to get.

Many other urban surveys in India (and elsewhere) have shown that, rather than equipment investment costs or higher relative prices, the main deterrents to the use of kerosene for cooking are shortages of kerosene in the poorer districts, long queues at the low price 'ration shops', and other supply difficulties.

With the next fuel up the income ladder, bottled gas (LPG), equipment costs are normally severe deterrents to the poor. In Colombo in 1983, for instance, the entry cost for LPG cooking was Rs 1,940 (US$ 90), including Rs 870 for the cheapest two-ring cooker, Rs 750 for a 13 kg gas cylinder and Rs 120 for the gas itself. This sum represented at least one month's income for 70 per cent of households and nearly five months' income for the poorest 12 per cent [Central Bank 1985; Leach 1986]. In India in 1979 the initial investment for LPG cooking was 34 per cent of annual income for the poorest 30 per cent of average urban households, but only three per cent for the highest income families [Natarajan 1985; Leach 1986].

Improvements in the supply, distribution and marketing systems for kerosene, both in low income districts of cities and in towns generally, are one obvious policy need. Essentially, as great a priority needs to be given to the distribution of household kerosene as it now is to motor gasoline or industrial fuel oil.

Much could also be done to lower the cost and improve the efficiency and versatility of kerosene stoves, and reduce the initial costs of LPG systems. Little effort has gone into the indigenous design and manufacture of low cost, standard size gas cookers (i.e. with ovens and grills which can replace the baking and charring capabilities of the wood fire/stove, unlike the standard kerosene cooker) or into cheap 'camping gas' stoves and small (one to three kg) gas cylinders.

In the meantime, subsidies on kerosene stoves and (small) LPG systems, or capital loan schemes, are ideas that seem worth exploring. Their benefit/cost ratios are likely to be high so long as they are judged in the broad context of increasing deforestation and related environmental pressures as a result of rising woodfuel demand by the urban centres and the poor within them.

In conclusion, one has to ask who is to effect these ideas. A key point in this regard is the diversity of urban fuel consumption patterns in relation to income, and the great variety of fuel prices and other market conditions, from one city to the next. Most policies and actions must be tailored to local conditions. This suggests that city rather than central governments must take the lead where appropriate (e.g. on pricing and subsidies) and, more importantly, that the most successful and appropriate changes are likely to come only from local 'grass roots' organisations with their generally strong social commitment, motivation and ability to invent new approaches which are properly matched to local needs.

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