CHAPTER 2

energy and social issues

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ABSTRACT

Poverty is the most fundamental reality of developing countries—and the energy consumption patterns of poor people tend to add to their misery and aggravate their poverty. A direct improvement in energy services would allow the poor to enjoy both short-term and long-term advances in living standards. Required are energy strategies based on increasing the use of energy carriers other than biomass, or on using biomass in modern ways. Poverty alleviation and development depend on universal access to energy services that are affordable, reliable, and of good quality.

It has been noted that "poverty has a woman's face". Energy and women are linked in many diverse ways, particularly through the nature of the (predominantly biomass) energy resource base, the characteristics of the household and community economy, the features of energy policy, and the position of women in families and communities. Energy can be a vital entry point for improving the position of women in households and societies.

Many of today's global problems arise from the availability and use of natural resources, which depend on the size of the human population putting pressure on them. But population is more than just an external factor influencing energy consumption. Energy consumption patterns can also influence population growth through their effect on the desired number of births in a family and the relative benefits and costs of fertility.

Energy is linked to urbanisation through its implications for land use, transportation, industry, construction, infrastructure, domestic appliances and products, biomass consumption, and gender. Energy strategies can be designed to improve the urban environment—particularly for transport, industrialisation, mitigation of heat island effects, and construction.

Although energy devices (houses, vehicles, appliances) have become much more efficient in industrialised countries, the number and use of these devices have increased markedly. If appliances and their use (the material basis of lifestyles) are taken as determinants of energy consumption, then strategies can be devised based on reducing the number and use of energy-intensive appliances.

Almost every industrialised country has poor and disadvantaged populations. But the energy aspects of poverty are radically different for industrialised and developing countries. Energy exacerbates poverty in industrialised countries—for example, through the disconnection of energy services or the absence in cold countries of universal affordable warmth.

There are two-way linkages between energy and poverty, women, population growth, urbanisation, and lifestyles. That is, these global issues determine energy consumption, and energy systems influence the issues. Current energy consumption patterns are aggravating these global issues, leading to unsustainability. But energy can also help solve major global problems—particularly those related to poverty, women, population growth, urbanisation, and lifestyles. To realise this potential, energy must be brought to centre stage and given the same importance as the other major global issues. ■

What human beings want is not oil or coal, or even gasoline or electricity per se, but the services that those energy sources provide.

Human society cannot survive without a continuous use, and hence supply, of energy. The original source of energy for social activities was human energy—the energy of human muscle provided the mechanical power necessary at the dawn of civilisation. Then came the control and use of fire from the combustion of wood, and with this, the ability to exploit chemical transformations brought about by heat energy, and thereby to cook food, heat dwellings, and extract metals (bronze and iron). The energy of flowing water and wind was also harnessed. The energy of draught animals began to play a role in agriculture, transport, and even industry. Finally, in rapid succession, human societies acquired control over coal, steam, oil, electricity, and gas. Thus from one perspective, history is the story of the control over energy sources for the benefit of society.

Modern economies are energy dependent, and their tendency has been to see the provision of sufficient energy as the central problem of the energy sector. Indeed, the magnitude of energy consumed per capita became an indicator of a country's 'modernisation' and progress. Energy concerns have long been driven by one simple preoccupation: increasing the supply of energy. Over the past few decades, however, serious doubts have arisen about the wisdom of pursuing a supply-obsessed approach. Attention is shifting towards a more balanced view that also looks at the demand side of energy. But access to, and the use of, energy continues to be a necessary and vital component of development.

In the supply-driven approach, the appetite for energy often exceeded the capacity of local sources of supply. The energy supplies of some countries had to be brought from halfway round the world. Efforts to establish control over oil wells and oil sea routes have generated persistent tensions and political problems. This situation has also shaped national policies for foreign affairs, economics, science, and technology—and influenced the political map of the world. The security of energy supplies was a major geostrategic issue throughout the 20th century.

At the same time, the magnitude and intensity of energy production and use began to have deleterious impacts on the environment. By the late 1960s the gravity of the environmental problems arising from toxic substances had become clear. Awareness of the environmental issue of acid rain followed. The problems of urban air pollution have been known for a long time. Climate change discussions intensified in the mid-1970s. All these problems are directly related to the quality and quantity of fuel combustion.

Then came the oil shocks of 1973 and 1979, along with price increases that led to economic disruption at international, national, and local levels. The oil shocks thrust the energy problem into the range of awareness of individuals. Some oil-importing developing countries suffered serious balance of payments problems, and in some cases landed in debt traps. The development of indigenous fossil fuel resources and power generation faced the hurdle of capital availability. And more recently, the accumulation of greenhouse gases in the atmosphere resulting from energy consumption has focussed attention on the threat of climate change, with the possibility of far-reaching consequences. In parallel, the lack of control over energy resources has highlighted the importance of national and local self-reliance (as distinct from self-sufficiency).[1]

Thus, quite apart from the critical issues related to the supply of fossil fuels, the political, social, and economic institutions dealing with energy have failed to overcome a new series of grave problems—problems of economics (access to capital), empowerment (self-reliance), equity, and the environment. Many of the human-made threats to the species and the biosphere, indeed to civilisation's future, are energy-related. Awareness of the energy dimensions of these issues has arisen more recently, but the underlying energy bases of the issues are still imperfectly appreciated by decision-makers, perhaps because this understanding has not been disseminated widely.

This chapter is devoted to the main linkages between energy and social issues. It shows that energy strategies have impacts on major issues related to poverty, women, population, urbanisation, and lifestyles. Data on infant mortality, illiteracy, life expectancy, and total fertility as a function of energy use are shown in figure 2.1, which is not meant to suggest that there is a causal relation between the parameters represented.[2]

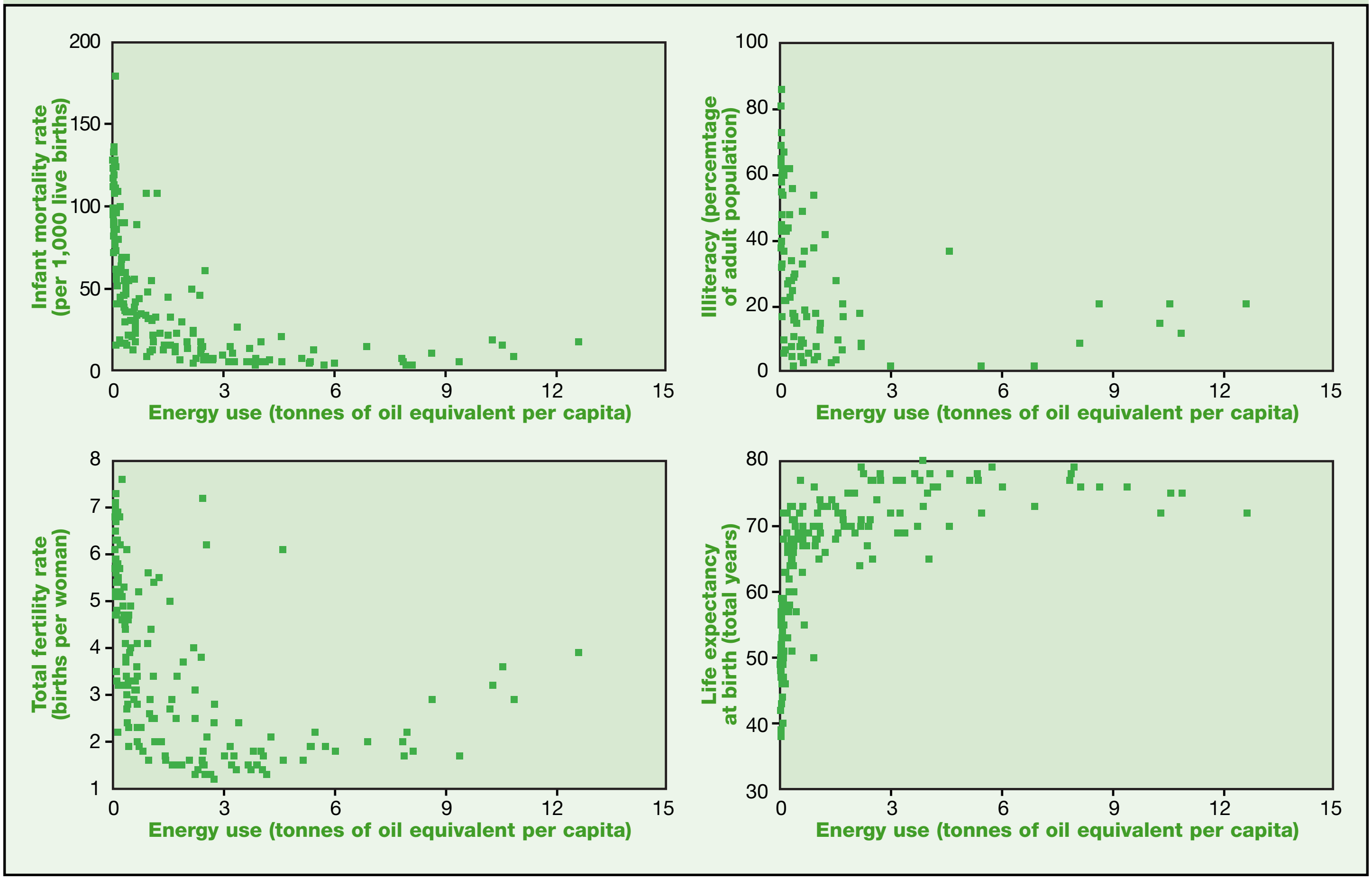
These linkages imply that energy has to be tackled in such a way that social problems are at least not aggravated—which is what conventional energy strategies tend to do, because they are so preoccupied with energy supplies that they ignore these problems completely or deal with them inadequately. Because of its linkages to social problems, energy can contribute to their solution. Unfortunately, energy and the major problems of today's world are not being dealt with in an integrated way by national and international policy-makers.

Towards a new approach to energy for human uses

Another approach is called for: one that recognises that the satisfaction of social needs by energy is best achieved by treating neither energy supply nor energy consumption as ends in themselves. After all, what human beings want is not oil or coal, or even gasoline or electricity per se, but the services that those energy sources provide. Thus it is important to focus on the demand side of the energy system, the end uses of energy, and the services that energy provides.

In fact, one can identify a rather small set of the most important of these energy services. They include the basic services of cooking, heating, lighting, space conditioning, and safe storage of food. In addition, the provision of clean water and sanitation, which is facilitated by energy, affects public health in cities as well as rural areas. Societies also require services such as transportation, motive power for industry and agriculture, heat for materials processing

FIGURE 2.1. COMMERCIAL ENERGY USE AND INFANT MORTALITY, ILLITERACY, LIFE EXPECTANCY, AND FERTILITY IN INDUSTRIALISED AND DEVELOPING COUNTRIES



Note: Data on commercial energy use are for 1994; data on social indicators are for 1995.

Source: World Bank, 1997.

(steel, cement, and so on), and energy for commerce, communication, and other economic and social activities.

The demand-side, end-use-oriented energy services approach stresses another difference. The end user cares less about the original sources or fuels used to provide the service than about crucial attributes of the final energy carrier from a social standpoint. Among the most important attributes are energy's accessibility (particularly for the poor, women, and those in remote areas), affordability, adequacy, quality, reliability, safety, and impact (particularly on the immediate environment).

The traditional supply-side approach tends to forecast energy demand on the basis of projections of past and present economic and demographic trends. It tends to ignore the large variety of scenarios that are feasible considering the opportunities and potentials offered by changes in energy demand, improvements in energy efficiency, shifts from traditional energy sources to modern energy carriers, and dissemination of new energy technologies.

To best serve humanity, the energy system should help achieve the goals laid down at the 1992 United Nations Conference on Environment and Development (the so-called Earth Summit) in Rio de Janeiro, and in other UN contexts. These goals include the promotion of economically viable, socially harmonious, environmentally safe, and strategically secure societies. Meeting these goals requires five crucial components: economic efficiency, equity (particularly for the poor, women, ethnic minorities, and those in remote areas), empowerment or self-reliance, environmental soundness, and peace. Together these components can be taken as some of the most essential measures of sustainable development.

The Earth Summit led to greater awareness that development needs to be sustainable if it is to serve humanity's short- and long-term goals. More than 150 governments committed themselves to the protection of the environment through the Rio Declaration and Agenda 21. Government representatives considered that key commitments related to energy would be covered under the United Nations Framework Convention on Climate Change (UNFCCC), which was signed on this occasion. Agenda 21 makes this important statement:

> Energy is essential to economic and social development and improved quality of life. Much of the world's energy, however, is

> currently produced and consumed in ways that could not be sustained if technology were to remain constant and if overall quantities were to increase substantially. The need to control atmospheric emissions and other gases and substances will increasingly need to be based on efficiency in energy production, transmission, distribution and consumption, and on growing reliance on environmentally sound energy systems, particularly new and renewable sources of energy. (UN, 1993b, ch. 9.9)

> Indoor air pollution is a major by-product of the traditional use of biomass, which diminishes the quality of life, especially for women and young children.

The Framework Convention on Climate Change, which has been ratified by 164 countries, defines an ecological target—without linking this target to social impacts!— that implies the implementation of energy measures. The Intergovernmental Panel on Climate Change (IPCC) also has presented scientific assessments of data related to climate change and prospects for inputs, adaptation, and mitigation of climate change and their relationship to energy issues.

Since the Earth Summit many other initiatives have been taken at various levels to promote sustainable energy through increased energy efficiency, support for renewable energy sources, and integrated energy resource planning. There are now good examples, significant benchmarks, and success stories all around the world of efforts in these areas. But these efforts are dispersed. Though they provide a good starting point, they cannot meet the tremendous energy challenges facing humanity during the 21st century.

Energy issues tend to get sidelined in many international forums. Such major global issues as poverty, women, population, urbanisation, lifestyles, undernutrition, environment, economics, and security tend to get higher priority than energy. But missing from most discussions of these issues is the important linkage between each of them and global and local energy systems. It is too little appreciated that achieving progress in these other arenas can be greatly assisted by manipulation of energy systems.

Even when this linkage is mentioned, the discussion focuses on how these global issues determine energy consumption patterns. Energy is treated as the dependent variable. Very little attention is directed at understanding whether current energy patterns are aggravating these issues, and almost no attention is given to how alternative energy strategies can contribute to their solution.

Thus a fresh conceptual framework is required. The framework elaborated in this chapter, and depicted in figure 2.2, concerns the linkage between energy, on the one hand, and poverty, women, population, urbanisation, and lifestyles, on the other.[3]

The linkage between energy and food security is also crucial, particularly because it concerns the important social problem of undernutrition that is so widespread and serious, especially in developing countries. Despite this, the energy-undernutrition dimension is not addressed in this chapter, primarily because of space considerations. Moreover, the energy-undernutrition link has been treated adequately in other contexts, particularly in *Energy after Rio: Prospects and Challenges* (UNDP, 1997a), which explains how energy strategies can play a powerful role in increasing the supply of food as well as building an environment in which food is absorbed more effectively.

As humankind enters the new millennium, it is important to highlight energy's critical relationship to major global problems. The timeliness of the challenge derives from three critical elements that are converging to make the world thirstier for energy services: aspirations for a higher living standards, booming economies in large regions, and population growth.

The assessment that follows draws together a number of diverse elements that are relevant to sustainable development, and for which issues of supply and demand of energy are significant. It goes on to show new options for using energy more efficiently, and also how both renewable and fossil sources of energy can be used in cleaner, more efficient ways to help create a more sustainable future. In fact, the global goal for energy can be stated very simply: sustainable development of the world. Energy services therefore are a necessary condition for sustainable development.

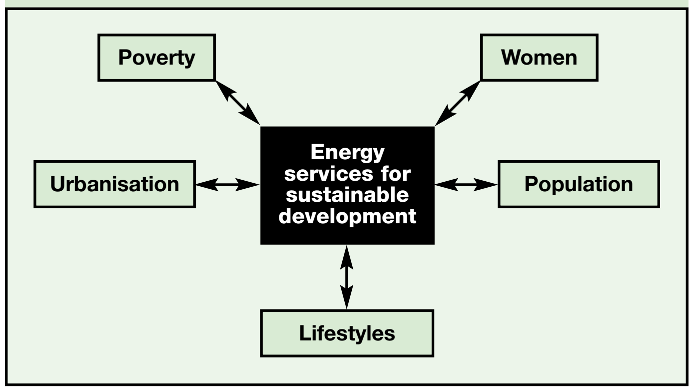
Energy and poverty in developing countries

Poverty is the most fundamental reality of developing countries.[4] Poverty refers to an individual's (or family's) lack of access—associated primarily with inadequate income—to basic human needs such as food, shelter, fuel, clothing, safe water, sanitation, health care, and education. Poverty is manifested as the inability to achieve a minimum standard of what is needed for material well-being. Human poverty also entails the denial of opportunities and choices most vital to human development—including a long, healthy, creative life, a decent standard of living, dignity, self-esteem, the respect of others, and the things that people value in life.

Dimensions of poverty

Poverty is usually conceptualised and measured in terms of the proportion of people who do not achieve specified levels of health,

FIGURE 2.2. ENERGY AND SOCIAL ISSUES



> Because efficient devices tend to have higher first costs, the poor invariably end up with less efficient devices that consume more energy for a given level of service.

education, or body weight. Operationally, however, poverty standards are typically expressed in a single dimension: the monetary resources that would enable an individual to consume either a fixed bundle of basic goods and services (absolute poverty[5]), or a fraction of the bundle of goods and services that a reference group is able to, or actually does, consume (relative poverty).

UNDP's human poverty index goes beyond mere income poverty. It measures deprivation in three essential dimensions of human life: longevity (or vulnerability to death at an early age), knowledge (access to reading and communication), and a decent standard of living in terms of overall economic and social needs (percentage of people without access to safe water and health services and the percentage of underweight children under five).

Whether measured directly with a range of indicators of basic human outcomes, or indirectly with a single monetary dimension, poverty is indisputably among the world's largest, most urgent, and most fundamental problems. Its pervasiveness—as revealed by the extent to which elementary minimum needs are not satisfied—is undeniable. Whether food, shelter, health, education, or employment is considered, living standards of the majority in most developing countries are pathetically low. They represent a full-time struggle for survival—a type of existence largely unknown, and perhaps even unimaginable, in industrialised countries. This struggle is quite apart from associated psychological reactions of deprivation and feelings of hopelessness and social disempowerment, often accompanied by deep feelings of personal need.

In perhaps the most ambitious and careful attempt yet undertaken to measure absolute poverty in developing countries, it has been estimated that, as of 1993, roughly 1.3 billion people in developing countries—30 percent of their total population—consumed less than $1 a day worth of goods and services.[6]

Statistics on the inability of people in developing countries to satisfy basic human needs corroborate the enormous scale of poverty and highlight its breadth and complexity. For example, an estimated 20 percent of people in developing countries do not have access to health services, 30 percent lack access to safe water, and 61 percent lack access to sanitation (UNDP, 1996). And infant and child mortality rates in developing countries are more than 5 times higher than in industrialised countries, the proportion of children below age five who are underweight is 8 times higher, the maternal mortality rate is 14 times higher, and the proportion of births not attended by trained health personnel is 37 times higher.

Significant and widening disparities in human development and poverty are also found within countries between the rich and the poor, between rural and urban areas, between regions, between different ethnic groups, and between women and men. And income and development inequalities are greater within developing countries than within industrialised OECD countries. The richest 10 percent account for nearly half of national income or consumption in Brazil and South Africa. In contrast, the richest 10 percent in countries such as Germany, Japan, Norway, Switzerland, and the United States account for about 25 percent of their country's national income and spending. Industrialised countries not only have higher human development and lower poverty indexes; they are also more equitable than developing countries. But there has been overall progress in human development over the past 30 years, as indicated by an examination of measures such as UNDP's Human Development Index (HDI). On average, a child born in a developing country today can expect to live 16 years longer than a child born in 1970. Adult literacy rates since then have increased by nearly half (UNDP, 1998).

Yet these favourable aggregate trends mask slow progress or even setbacks in many countries, especially among the poorest people. For example, life expectancy in Africa is still 20 years lower than in East Asia or Latin America and the Caribbean. And adult literacy rates in South Asia (51 percent) are shockingly lower than in Southeast Asia (90 percent) or in nearly all industrialised countries (UNDP, 1998).

The alleviation, if not eradication, of poverty is among the world's largest, most urgent, and most fundamental challenges—and not merely for humanitarian reasons. Societies with grave inequalities and disparities tend to be unstable. Large populations below the poverty line are explosive material for social upheavals. Thus poverty has politically unsustainable characteristics. It merits urgent consideration and immediate action.

The energy-poverty nexus

Energy services are a crucial input to the primary development challenge of providing adequate food, shelter, clothing, water, sanitation, medical care, schooling, and access to information. Thus energy is one dimension or determinant of poverty and development, but it is vital. Energy supports the provision of basic needs such as cooked food, a comfortable living temperature, lighting, the use of appliances, piped water or sewerage, essential health care (refrigerated vaccines, emergency and intensive care), educational aids, communication (radio, television, electronic mail, the World Wide Web), and transport. Energy also fuels productive activities, including agriculture, commerce, manufacture, industry, and mining. Conversely, lack of access to energy contributes to poverty and deprivation and can contribute to economic decline.

The energy dimension of poverty—energy poverty—may be defined as the absence of sufficient choice in accessing adequate, affordable, reliable, high-quality, safe, and environmentally benign energy services to support economic and human development. The numbers are staggering: 2 billion people are without clean, safe cooking fuels and must depend on traditional biomass sources; 1.7 billion are without electricity. Increased access to such energy services will not, in itself, result in economic or social development. But lack of adequate energy inputs can be a severe constraint on development. Universally accessible energy services that are adequate, affordable, reliable, of good quality, safe, and environmentally benign are therefore a necessary but insufficient condition for development.

The energy ladder and household decisions about fuel choice

Poor people tend to rely on a significantly different set of energy carriers than the rich. The poor use proportionately more wood, dung, and other biomass fuels in traditional ways, and less electricity and liquefied petroleum gas (LPG). To illustrate this point, evidence from Brazil is shown in figure 2.3.

The observation that roughly 2 billion people depend mainly on traditional fuels for cooking is significant in part because indoor air pollution is a major by-product of the traditional use of biomass. This pollution diminishes the quality of life, especially for women and young children.

Households use fuel for a variety of activities, including cooking, water heating, lighting, and space heating. Different energy carriers can be used for each of these activities. For instance, firewood, dung, charcoal, coal, kerosene, electricity, and LPG can be used for cooking; and kerosene and electricity for lighting.

These carriers (for a particular activity) form what is commonly referred to as an 'energy ladder' for that activity. Each rung corresponds to the dominant (but not sole[7]) fuel used by a particular income group, and different income groups use different fuels and occupy different rungs (Hosier and Dowd, 1987; Reddy and Reddy, 1994). Wood, dung, and other biomass fuels represent the lowest rung on the energy ladder for cooking. Charcoal and coal (when available) and kerosene represent higher steps up the ladder to the highest rungs, electricity and LPG.

The ordering of fuels on the energy ladder also tends to correspond to the efficiency of the associated systems (the fraction of energy released from the carrier that is actually used by the end-use device) and their 'cleanliness'. For example, the cook-stove efficiencies of firewood (as traditionally used), kerosene, and gas are roughly 15, 50, and 65 percent, respectively. As one proceeds up the energy ladder, the emission into the air of carbon dioxide, sulphur dioxide, and particulates also tends to decline.

Households seem to make choices among energy carrier options on the basis of both the household's socioeconomic characteristics and attitudes and the attributes of alternative carriers. Income is the main characteristic that appears to influence a household's choice of carrier (Leach, 1992; Reddy and Reddy, 1994).

Relevant attributes of energy carriers include accessibility, convenience, controllability, cleanliness, efficiency, current cost, and expected distribution of future costs. Because different fuels require different appliances—stoves, lamps, and so on—with varying costs and durability, fuel costs have both fixed and variable components.

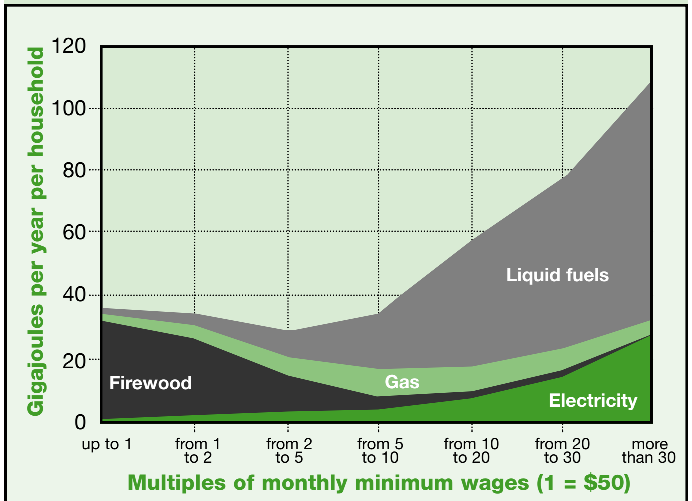
The importance of this distinction between fixed and variable costs is magnified by three factors: the presence of quasi-fixed costs, such as fixed monthly charges for a natural gas or electricity hookup; the need to make large 'lumpy' purchases of some fuels, such as tanks for storing propane gas; and the need to make sometimes sizeable security deposits, either to guarantee the payment of monthly bills or the return of equipment such as LPG cylinders or canisters. Despite the fact that they are refundable, security deposits impose a present cost on households, the magnitude of which depends upon the return on those funds in their next best use, or their 'opportunity cost'.

The division of costs into fixed, quasi-fixed, and variable components affects household decisions about fuel choice. The outcome of these decisions depends on the household's preparedness to forgo present consumption for future benefits. The degree to which a household discounts future benefits may be determined in part by its level of wealth and its liquidity. Households may apply high discount rates to fuel consumption decisions, because of the high cost of either diverting resources from other uses or of borrowing funds to cover up-front capital costs. Thus they will tend to prefer fuel carriers that involve lower up-front or first costs. Poor people use much higher discount rates than the rich when making energy carrier decisions (Reddy and Reddy, 1994). Lack of reliable income may force them to think almost solely in terms of the first cost, rather than the life-cycle cost. Because efficient devices tend to have higher first costs, the poor invariably end up with less efficient devices that consume more energy for a given level of service. Fuel costs may be determined either in a market or implicitly in terms of the opportunity cost of time spent gathering the fuel, such as firewood.

Energy strategies for alleviating poverty in developing countries

The poor pay more money, or spend more time for energy services, than those who are better off. This has a powerful implication. The economic hardship endured by poor households is understated

FIGURE 2.3. AVERAGE ENERGY DEMAND BY INCOME SEGMENT IN BRAZIL, 1988



Source: De Almeida and de Oliveira, 1995.

when their income (consumption expenditure) is evaluated in terms of its command over the basket of goods and services purchased by households with average income or consumption expenditures.

Further, in many places, poor households could achieve the same level of energy services at much less daily cost if they could move up the energy ladder to LPG or electricity. Demonstration projects have shown that the price that the poorest household is prepared to pay for electric lighting is near the full cost because the alternative of kerosene lamps involves much higher expenditures.

Substitution of energy carriers or devices that enable greater efficiency would confer sizeable gains in purchasing power on poor urban households. This analysis of the expenditure patterns of households in different income groups suggests that such an increase in effective resources would be devoted almost entirely to better satisfying basic needs for food, shelter, clothing, health, education, and additional fuel. Thus cost-effective improvements in energy efficiency have considerable potential to reduce poverty in all of its key dimensions.

It appears that the energy consumption patterns of poor people tend to add to their misery and aggravate their poverty for the following reasons:

- Because the poor pay more for daily energy needs, they are less likely to accumulate the wealth needed to make the investments that are necessary to make use of cheaper and more efficient fuels and appliances.
- The use of biomass compromises the health of household members, especially when it is burned indoors without either a proper stove to help control the generation of smoke or a chimney to draw the smoke outside. Thus in addition to its relatively high cost, the use of biomass fuel may promote higher medical care expenditures and diminish the poor's ability to work productively (chapter 3).
- Biomass also has deleterious environmental consequences outside the household. These effects are reinforced by the fact that biomass users are less likely to boil the water they drink, for reasons of cost or custom. Insofar as the use of biomass in urban areas promotes deforestation, reliance on biomass may also tend to increase its future cost, further diminishing the living standards of the poor (Leach, 1992; Dasgupta, 1993).

The linkages between energy and poverty have implications for strategies to alleviate poverty. The standard poverty alleviation strategies of macroeconomic growth, human capital investment, and wealth redistribution do not directly address the energy-poverty nexus in developing countries. If patterns of energy use among the poor depress their nutrition, health, and productivity, the poor are likely to absorb the benefits of economic growth only very slowly. Education will continue to increase their earning capacity, but by less when kerosene rather than electricity is the main illuminant, when lighting is poor, and when access to knowledge though radio and television is limited. The situation is worsened when traditional biomass is the dominant cooking fuel: school attendance flags because of the burden of collecting it and the respiratory illness caused by cooking with it.

Dramatic increases in living standards in developing countries can theoretically be achieved with small inputs of energy.

In contrast, strategies that, in addition to standard poverty alleviation strategies and rural development, include direct improvement of energy services allow the poor to enjoy both short-term and self-reinforcing long-term advances in their living standards. Such strategies should promote increased use of energy carriers other than biomass, or use of biomass in modern ways.

In fact, this approach suggests that major advances in poverty alleviation can be achieved with relatively small inputs of energy, as evidenced from the so-called 1 kilowatt per capita scenario (Goldemberg and others, 1985). This scenario was based on a 'thought experiment' in which the following question was explored: If all developing countries achieved a level of energy services comparable to that of Western Europe in the 1970s,[8] and if they deployed the most efficient energy technologies and energy carriers available in the 1980s, what would be the per capita energy consumption corresponding to this vastly improved standard of living?

The surprising answer was that, provided that the most energy-efficient technologies and energy carriers available are implemented, a mere 1 kilowatt per capita—that is, a 10 percent increase in today's energy per capita—would be required for the populations of developing countries to enjoy a standard of living as high as that of Western Europe in the 1970s. In other words, dramatic increases in living standards in developing countries can theoretically be achieved with small inputs of energy.[9]

Energy and poverty in industrialised countries

Almost every industrialised country has its poor and disadvantaged, but the energy aspects of their poverty are radically different from those for developing countries. The poor in industrialised countries are not energy poor in an absolute sense. Indeed, the direct use of energy by the poor in the United States for homes and automobiles is 1.65 times the average use in developing countries for all purposes, including the indirect use of energy for industrial and commercial purposes and public transportation. The high energy expenditures of the poor relative to those in developing countries are also not an indicator of affluence. These expenditures are essential to meet basic needs in the industrialised country context. The poor in industrialised countries consume much more energy than their counterparts in developing countries because of the much wider use of energy-intensive technologies.

Despite this apparent energy affluence of the poor in industrialised countries relative to the masses in developing countries, their economic plight cannot be ignored. The poor in industrialised countries spend a larger fraction of their income on energy relative to the average. Energy patterns clearly exacerbate poverty in industrialised countries—just as they do in developing ones. This linkage is not taken into account in conventional energy planning and policy-making. Rather, conventional energy strategies adopt the 'energy trickle-down' approach to social welfare and implicitly assume that if energy supplies are increased, these problems will take care of themselves. In industrialised countries the problem is not that the poor do not have access to enough energy to satisfy their needs, but rather that their circumstances require them to consume too much energy and therefore to spend too large a fraction of their income on it. If they cannot meet this expenditure, their access to energy is disrupted.

An alternative energy strategy is needed that addresses the energy-poverty link in industrialised countries and makes the poor less vulnerable to the high costs of energy. The most promising approach is to make available to the poor more energy-efficient technologies for space heating, household appliances, and transportation services.

A central challenge for many developing countries is the expansion of access to electricity for the poor. In contrast, maintaining access is the critical issue in some medium-income countries and economies in transition, as well as in OECD countries. The uninterrupted availability of access to vital energy services is particularly important to the poor, highlighting the health and other hazards associated with the lack of heating and light. Disconnection can be life-threatening. It is part of the general question of how the poor should be protected during the liberalisation and privatisation that are sweeping electric utilities around the world. There is increasing recognition of the importance of dealing with material hardship (lack of access to energy) rather than just income poverty in both industrialised and developing countries.

Energy and women

Poverty has a woman's face. Of the approximately 1.3 billion people living in poverty, 70% are women. (UNDP, 1997a. p. 12)

Compared to men, women in developing countries spend long hours working in survival activities…[This] time spent…is largely invisible in current methods of reporting energy patterns and statistics. (UNDP, 1997a, p. 15)

In developing countries, biomass accounts for about one-third of all energy and nearly 90% in some of the least-developed countries. About two billion people rely mainly or exclusively on traditional fuels (mostly biomass) for their daily energy needs. (UNDP, 1997a, pp. 36–37)

Human energy conservation must be central to any energy strategy, as it is a major component of energy used at the domestic level. The traditional division of labour allocates most tasks to women in the household. (Viklund, 1989, p. 10)

Energy and women are linked in many diverse ways.[10] These linkages vary spatially, over time, across classes, between urban and rural areas, and between countries. Some of these variations are common to women, men, and children of a given era, class, or country. But certain features of the relationship between energy and women are worth considering.

Factors determining energy-women linkages

Four main factors influence the nature of linkages between energy and women: the nature of the (energy) resource base, the characteristics of the household and community economy, the features of energy policy, and the position of women in families and communities.

Resource base. The survival and lives of most people in the developing world depend on the biomass resource base, rather than on coal, oil, or nuclear energy. Their consumption of energy (other than human energy and animate energy sources) is for survival needs, primarily cooking. For these needs, most people depend on biomass sources such as fuelwood, crop residues, and animal dung.

But this biomass resource base is being degraded.[11] As a result, in the course of a single generation, the time and effort required to meet minimum household energy needs have increased. Because many households rely on biomass fuels that are gathered or received as payment for services rendered, national energy accounts tend to under-represent the importance of biomass fuels as energy sources.

Likewise, labour and human investment (contributed primarily by women) added to this resource base are not fully understood or recognised. In fact, only fairly recently has it become accepted that deforestation in most areas is not caused by household use of fuelwood. Nonetheless, the cost (human effort and financial outlay) involved in securing household energy needs has escalated to such an extent that many households have been forced to shift to less efficient and less clean fuels. The health impacts on women and children of exposure to high concentrations of particulate matter, carbon monoxide, and hundreds of other pollutants emitted when biomass fuels are burned have been investigated and documented in some depth during the past 20 years (see chapter 3).

Household and community economy. Energy choices depend on the extent to which the local economy is based on subsistence agriculture or on raising livestock. A further issue is the degree of monetisation of the economy, and whether wages are paid in cash or in kind—for instance, in grain or, more pertinently, in crop residues. Each of these variables may influence the choices made—whether fuel is gathered or bought, whether improved (more efficient and less polluting) stoves are adopted, and what type of fuel is used.

Like the resource base, the local economy is dynamic, particularly now that macroeconomic factors are bringing about vast changes in microeconomies. These factors will determine the disposable income of households, as well as the opportunity costs of depending on the labour and time of women and children to supply household energy needs.

Energy policy. The linkages between women and energy are also shaped by the prevailing energy policy, especially its degree of sensitivity to the needs and priorities of (rural) women. Particularly in many developing countries, energy policy is designed in such a way that energy resources are not equally available to all. Industrial, commercial, urban, and male users receive priority service and attention in energy policies. At the bottom of the list are agricultural, domestic, rural, and female users. The structure and functioning of the energy sector also cater to those in the favoured categories.

The effect of these biases and predilections is evident in the rural areas of most developing countries. Even well-intentioned initiatives such as rural electrification often begin and end with a 'pole in every village'. Few affordable, viable options have been developed for the domestic sector, where much of women's work occurs.

Position of women in families and communities. One can see evidence in many places of a highly degraded biomass energy resource base. Yet investments to improve kitchens, stoves, and cooking fuels either do not figure in the hierarchy of household expenditures or appear very low on the list. Why?

A partial answer is that the livelihoods of people living in such environments are also under threat. In other words, they have other, even more urgent priorities. But another and crucial part of the answer is related to the position of women in families and communities.

The four factors discussed here—the energy resource base, the local economy, energy policy, and the position of women in families and communities—are closely connected. But the last of these factors is perhaps more fundamental than the others. It is a root cause, the reason it is necessary to study linkages not only between women and energy but also between women and a range of productive assets and social services. Women, by virtue of their position in society (or lack thereof), stand disadvantaged in decision-making processes in family, community, and country, as well as in accessing productive assets. Poor women in developing countries are doubly disadvantaged, while their sisters in rural areas are triply disenfranchised. Two aspects of this disenfranchisement that have particular bearing on the linkages between women and energy deserve closer attention: the value assigned to women's labour and the value placed on women's time.

- Valuing women's labour. Across cultures and economic rankings, women's work has been under-valued, sometimes to the extent that it has been rendered invisible. This applies not only to women's reproductive work and household work but also to their immensely active participation in the so-called informal sector of the economy. This under-valuation, in terms of what is included in the UN System of National Accounts (SNA) and what is not, is similar in industrialised and developing countries.[12] In both cases only about one-third of women's work is taken into account. Two-thirds is left out.

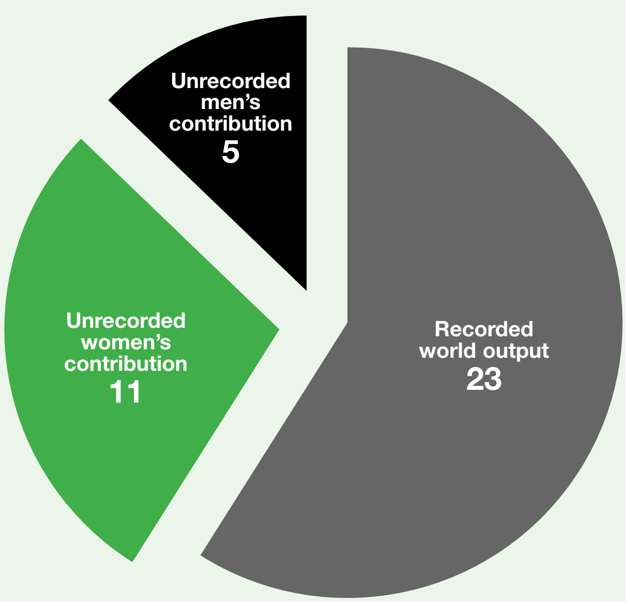
  Women's contribution to world output is also under-valued, and to a much greater extent (figure 2.4). According to published statistics, world output in 1993 totalled $23 trillion. But this reflects only recorded economic activity—and the unrecorded economic contributions of women are almost 45 percent of this amount (UNDP, 1995).

  Furthermore, women are under-paid relative to men for the same tasks. Again, this applies both in industrialised and developing countries. Women also shoulder the burden of household survival activities (cooking, cleaning, collecting fuel and water, and caring for children, plus sometimes raising kitchen gardens), all of which are largely unacknowledged. The result is that across the globe, women work longer hours than men. One of the most tangible linkages between women and energy is that the growing scarcity and cost of cooking fuel have lengthened women's workdays and made them more arduous.

- Valuing women's time. Rural women in developing countries have been forced to become experts at multitasking.[13] Faced with impossible workloads and only their own time and labour to fall back on, poor rural women have become very efficient at managing time. These skills are not assigned any value in the labour market. Even women often do not consider what they do as 'work'. Though the survival of the family—in literal as well as economic terms—may depend on the skill with which a woman manages her household, she has little or no economic decision-making power, and her time and her work have very low status. Not only are the cash-earning activities of the male members of the household given higher status, but even the leisure time of men may rank higher than the work time of women (Nathan, 1997).

To summarise, many of the world's women (roughly 400 million) rely on energy sources that are not part of the market economy in order to fulfil their survival activities and household responsibilities. They often depend on these sources for their economic activities as well. Women are more vulnerable than men to environmental degradation, because there is often a direct impact on their workload. They are also more likely to be directly affected by increases in fuel prices and by scarcity. Often the only asset that women can turn to

FIGURE 2.4. WOMEN'S SHARE OF WORLD OUTPUT, 1993 (TRILLIONS OF U.S. DOLLARS)



Source: De Almeida and de Oliveira, 1995.

in times of scarcity or high prices is their own bodies, their own labour. This results not only in longer workdays but also in declining health, nutrition, and a score of other ill effects. Apart from the overwhelming importance of biomass energy, the role of human energy and particularly of women's energy must be recognised (chapter 3).

Apart from the overwhelming importance of biomass energy, the role of human energy and particularly of women's energy must be recognised.

Specific concerns and priority areas

Health and sanitation. Thus there is a very direct link between energy and women's health. Most of the burdens placed by energy scarcity are borne by women. Even where biomass energy is relatively easily available, women feel the health impacts of having to collect fuelwood. These impacts may range from cuts, falls, bites, and back injuries to sexual harassment (Government of India, 1988). Often these problems are compounded by having to haul water for the household as well.

Exposure to indoor air pollution is another well-documented health risk associated with the use of biomass fuels in traditional stoves that are little more than shielded fires in poorly ventilated kitchens (WHO, 1992). Rural women and children in developing countries are most affected by this pollution. The rural-urban differential in pollutant concentrations and exposures is marked, as are differences between countries at different stages of human development (figure 2.5). The urban-rural differential is reversed in high-HDI countries, where exposures are higher due to the greater amount of time spent indoors and due to building characteristics and materials.

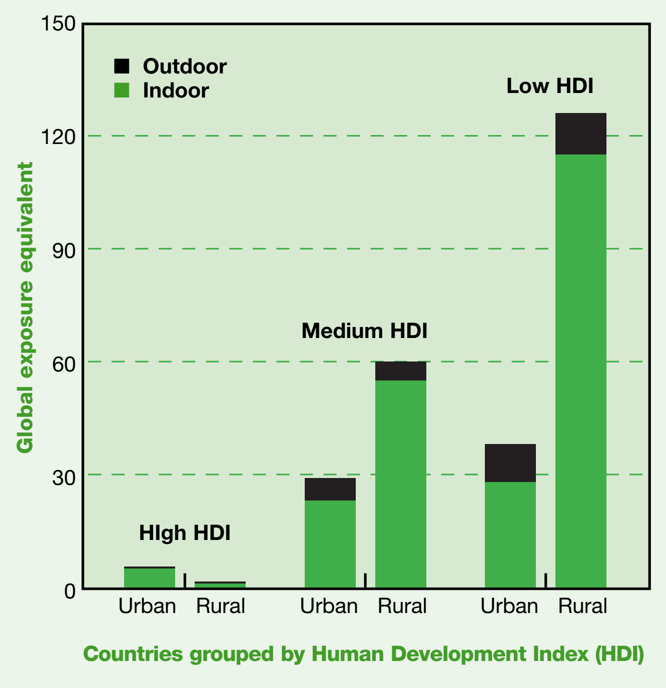
Fuel scarcity has wider implications. Women may be forced to move to foods that can be cooked more quickly or to eat more raw food. Such a shift can have health repercussions for the whole family, especially children (Batliwala, 1982; Ramakrishna, 1992).

An additional critical factor related to health is the lack of sanitation in many rural areas of developing countries, which is directly related to the difficulty of accessing clean water. There is an energy-sanitation link here because energy often has to be used to lift 'clean' sub-soil water or to boil water to reduce the health risk from contamination. The convenience of the water supply—for instance, the distance to the source and the number of sources—correlates with the amount of water used daily per capita. For most rural people in developing countries, the amount of clean water available per capita is well below the minimum required for maintaining sanitation. In addition, the supply of drinking water is highly inadequate. As water drawers and carriers and household managers, women feel the impact of water shortages most keenly. The availability, supply, and quality of water could be greatly improved by increasing the amount of energy available for these functions.

Environmental quality. Energy scarcity often relates directly to environmental quality for households and for communities in general. The implications of this relationship are particularly relevant for women. Deteriorating environmental quality places greater burdens on women's time and labour. In addition, as mentioned above, women's health and productivity may be significantly undermined. This is only partly due to the increased effort required to meet minimum household energy requirements. Energy, after all, is only one of the inputs that women must secure for survival. Water also becomes scarce with increasing environmental degradation. In cases of severe environmental decline, male migration often increases, as in Sub-Saharan Africa. In such circumstances women have to bear the additional responsibility of heading households. A key intervention to arrest or slow environmental degradation in many developing countries would be to increase the energy options for poor rural women. In particular, the potential of renewable energy sources has not been realised.

Economic activities. The linkages between women's economic activities and energy have two aspects. One is the strong correlation between the time women have for economic activities and the time they have for survival activities, including collecting and preparing cooking fuels. The other is securing energy inputs for economic activities. The main point is that women's choices are often very restricted, and they do not have much margin for error for the

FIGURE 2.5. GLOBAL EXPOSURE EQUIVALENTS FOR PARTICULATES IN 12 MAJOR MICROENVIRONMENTS



The global exposure equivalent is defined as the equivalent (particulate) concentration that the entire world's population would have to breathe continuously to equal the population exposure in each micro-environment.
Note: Data are for various years from the late 1980s to early 1990s.
Source: Based on Smith, 1993.

unforeseen. Given that most women, whether bakers, brewers, or food processors, are small-scale producers whose businesses are frequently biomass-energy intensive, both technology development and improved energy supply could greatly enhance their productivity.

Education. Despite momentous advances in the literacy of women, much remains to be done. As long as the drudgery of survival activities continues to grow, given the division of labour in most households, getting girls into schools will be an uphill battle. Improved access to better-quality, affordable, reliable cooking fuels could make an enormous difference. As it is, girls are the first to be called on to shoulder survival activities that cannot be managed by the adult women of the household. Invariably, girls' education suffers as a result.

Human productivity. The gravest consequence of energy scarcity is probably that human productivity—especially women's productivity—is depressed. When survival of the family becomes the goal, there is no opportunity to develop human potentials and talents. This is a loss not only to the individual, but to society as well.

Energy for improving the position of women

Energy can be a vital entry point or 'lever' for improving the position of women in the household and society. As a bottleneck and burden, the lack of affordable energy has often constrained the options and opportunities available to women. But there are many strategic advantages in using energy as an entry point.

Energy scarcity condemns many women to spend all their days and a good part of their nights meeting basic survival needs. Enhancing their access to affordable, clean energy sources would go a long way towards reducing the drudgery they face, and allow them to use their time and energy for other purposes. This could lead to improved health, education, nutrition, and economic status, not only for women but for their families as well. The greatest benefit would accrue to the next generation; and in particular to girls, who would gain—as their workload at home decreases—better health and nutrition and opportunities to go to school.

Energy is also a key productive asset for strengthening the economic standing of women. In many cases it is also necessary for providing equal access to productive resources (Batliwala and Reddy, 1996). Whether a woman is engaged in food processing or in farming, her economic return largely depends on a dependable supply of energy and on improvements in energy technology products relevant to her trade.

Energy is a good organising issue for women, because energy is a primary concern in their daily lives—especially poor women's. Energy resource scarcity, cost, quality, and reliability are their constant concerns. Whereas alone each woman may be able to do little to improve the situation, together their power could be fairly easily demonstrated. In some countries farmers (mainly men) have organised themselves to demand affordable and reliable energy supplies. Women can broaden these movements by adding their agenda.

> Energy can be a vital entry point or 'lever' for improving the position of women in the household and society.

Finally, energy provides many opportunities for skill building among women. That these skills would be non-traditional ones, and would not restrict women to the kitchen and home (as do those perennial-favourite income-generation schemes tailoring and pickle-making) are added advantages. The exploitation of such opportunities, combined with improved access to credit for women, could result in considerable entrepreneurial activity.

This perspective can also be turned on its head with good effect. Involving women more integrally in the energy sector could be a boon for the sector as well. The energy sector has evolved as a capital-intensive, expert-dominated, centralised sector. But there is a role for decentralised energy in which women can play an important part. In fact, the 'engendering' of the energy sector could be its salvation in the long run, leading to decentralisation, longer-term perspectives, and investment, and a better fit between energy source, energy quality, and end use—in other words, to a greater emphasis on renewable energy sources, in keeping with the underlying philosophy of sustainable development.

Energy and population

Many of today's global problems arise from the availability and use of natural resources, which depend on the size of the human population putting pressure on them. This pressure has been escalating in an alarming manner.

The world's population has increased explosively over the past 100 years. "It took the world population millions of years to reach the first billion, then 123 years to get to the second, 33 years to the third, 14 years to the fourth, 13 years to the fifth billion" (Sen, 1994). Additions to the population have been unprecedented: "Between 1980 and 1990, the number of people on earth grew by about 923 million, an increase nearly the size of the total world population in Malthus' time" (about 1800; Sen, 1994).

This explosive growth has led to talk of a runaway population inexorably bringing humanity to its doom and of a situation of 'standing room only' on this planet. But these predictions have generally assumed the persistence of the very high population growth rates of the 1950s, which corresponded to a doubling every 23 years or so.

Demographic transitions

The recent tremendous increase in world population is associated with what is known as a demographic transition. In such a transition, the population moves from a pre-industrial balance of high mortality and high fertility to a post-industrial balance of low mortality and low fertility.

Demographic transitions have occurred in the past—in Western Europe in the 19th century, and in Southern and Eastern Europe in the first quarter of the 20th century. They are now taking place all over the developing world. In some countries they are just starting. In others they are well under way. And in the remaining countries they are over or almost over.

The demographic transition currently under way in developing countries has been initiated by the rapid fall in mortality in these countries, brought about by improvements in public health and advances in medical technology. For example, an increase in life expectancy from 40 to 50 years was accomplished in developing countries in just 15 years, from 1950–65. In comparison, a similar increase of life expectancy required 70 years (from 1830–1900) in Western Europe and 25 years (from 1900–25) in southern and Eastern Europe.

If a large reduction in mortality were not accompanied by a fall in fertility, the population would increase indefinitely. But what happened in industrialised countries is that fertility also fell, and the low value of mortality was balanced by a new low value of fertility. Thus the growth rate of population is low both before and after the demographic transition during which the population grows rapidly:

> The rate of world population growth is certainly declining, and even over the last two decades, its percentage growth rate has fallen from 2.2 percent per year between 1970 and 1980 to 1.7 percent between 1980 and 1992. This rate is expected to go down steadily until the size of the world's population becomes nearly stationary (Sen, 1994).

The crucial question, therefore, is whether the reduction in mortality that took place in developing countries from 1950–65 has been followed by a fall in fertility. The evidence seems clear. Until the mid-1960s there was no sign of a fertility decline, but since then fertility has begun to fall in almost all developing countries, except those in Sub-Saharan Africa. The average total fertility rate in developing countries fell from 5.9 to 4.7, that is, by about 20 percent, from 1965–70.[14]

It is important to note that the response of fertility is not as rapid as the decline in mortality—fertility is not in sync with mortality. The delay in fertility decline leads to a 'bulge' in the time variation of population. This bulge gives rise to the problems associated with population size. Thus it seems that a demographic transition is taking place and that the population of developing countries and of the world is likely to stabilise eventually. But the world is sure to have a growing population for quite some time because of 'population momentum (Sen, 1994).

Population momentum

Population momentum has important geographic, locational, and age dimensions. First, the geographic distribution of population growth is uneven—90 percent of the growth is taking place in developing countries. These additions to population are primarily in populous countries with a low average income. In addition, the population explosion is worse in countries that already have a severe population problem. Second, the locational distribution of population growth is such that the urban share of growth has increased and will continue to go up.

Third, the age distribution of the population is changing in all countries, but the nature of the change varies among them. The population is becoming older in rich countries because life expectancy is increasing while infant mortality is relatively stable. In poor countries the age distribution depends on the phase of the demographic transition. In the initial phase the dependent non-working-age population grows faster because infant mortality is declining much more than the increase in life expectancy. In the middle phase the growth of the working-age population (with the potential of being economically active) is relatively greater.[15] And in the final phase, the elderly population grows faster.[16]

It is important to estimate this future population. An average of the 1992 UN medium estimate and the World Bank estimate of the future population yields 9.79 billion in 2050,[17] 11.15 billion in 2100, and 11.45 billion in 2150. In 1998 the UN Population Division projected 8.9 billion people by 2050, thanks to the fertility rate decreasing around the world (New York Times, 21 October 1998, p. A8). The bulk of the population increase is expected to take place in developing countries, where the population is expected to triple to 9 billion by 2110.

The increase in global population before its expected stabilisation by about 2100 means that per capita resources will continuously decline in the near future. In fact, per capita estimates conceal the differential growth that is likely to take place in industrialised and developing countries, which will exacerbate the already serious disparities between these two worlds.

The energy-population nexus

Population levels influence the magnitude of energy demand in a straightforward way: The larger the population, the more total energy is required, with the magnitude of this total energy depending on per capita energy consumption. This is perhaps the basis of a view that population increases in developing countries represent the most serious threat to the global atmosphere through the phenomenon of global warming (Atiq, Robins, and Roncerel, 1998).

There is an another view, however. The patterns of energy consumption in rich industrialised and poor developing countries, and the rich and poor within developing countries, are such that industrialised countries, and the rich within developing countries, have—because of their energy-intensive consumption patterns—far greater per capita impact on the global atmosphere. Hence the greater rates of population growth of poor developing countries, and the poor within developing countries, are far less relevant to global warming than the lower rates of population growth of industrialised countries, and the rich within developing countries. In fact, 49 percent of the growth in world energy demand from 1890–1990 was due to population growth, with the remaining 51 percent due to increasing energy use per capita.[18] This relationship will hold true for the future if per capita energy consumption does not change significantly.

Thus the conventional view of the energy-population nexus is that population is an external factor influencing energy consumption.

This exogenous impact of population on energy is the well-known (and obvious) aspect of the population-energy connection, although many people seem not to realise the scale of its impact even today.

Industrialised countries have—because of their energy-intensive consumption patterns—far greater per capita impact on the global atmosphere.

But there can be another connection, in which energy strategies may lessen the intensity of the population problem. If energy consumption and population growth are a dialectical pair—each transforming the other, and each being an effect when the other is the cause—then the pattern of energy consumption should also have an effect on population growth.

This is the other side of the coin—energy consumption patterns influencing the rate of population growth through their effect on the desired number of births in a family and the relative benefits and costs of fertility. These patterns can retard or accelerate the demographic transition (Goldemberg and others, 1988).

This dimension of the energy-population nexus—not yet elaborated sufficiently—will be sketched through the influence of energy consumption on population growth at two levels: the micro level of villages in developing countries and the macro level of the world. The implication is that energy can play a key role in accelerating the demographic transition, particularly by achieving dramatic reductions in fertility to stabilise global population as quickly as possible and at as low a level as possible.

Rural energy consumption and population implications

To proceed, several features of rural energy consumption in developing countries must be highlighted. Though these features vary with country and agroclimatic conditions, a few numbers typical of south Indian villages are presented to give a flavour of the features involved (ASTRA, 1982):

- Commercial energy accounts for a very small percentage of the inanimate energy used in villages; the bulk of the energy comes from fuelwood.[19]
- Animate sources—human beings and draught animals such as bullocks—account for less than 10 percent of the total energy, but the real significance of this contribution is that these animate sources represent the bulk of the energy used in agriculture.
- Nearly all the energy consumption comes from traditional renewable sources. Thus agriculture is largely based on human beings and bullocks, and domestic cooking (which uses the bulk of the total inanimate energy) is based entirely on fuelwood.[20] But the environmental soundness of this pattern of dependence on renewable resources comes at an exorbitant price. Levels of agricultural productivity are very low, and large amounts of human energy are spent on fuelwood gathering (for example, about 2–6 hours and 4–8 kilometres a day per family to collect about 10 kilograms of fuelwood).
- Fetching water for domestic consumption also uses a great deal of human energy (an average of 1.5 hours and 1.6 kilometres a day per household) to achieve an extremely low per capita water consumption of 1.7 litres a day.
- Almost half of the human energy is spent on grazing livestock (5–8 hours a day per household), which is a crucial source of supplementary household income in these parts of the country.
- Children contribute about one-third of the labour for gathering fuelwood, fetching water, and grazing livestock. Their labour contributions are vital to the survival of families. This point is usually ignored by population and education planners.
- The end uses of human energy in villages show that their inhabitants, particularly women and children, suffer burdens that have been largely eliminated in urban settings by the deployment of inanimate energy. For example, gathering fuelwood and fetching water can be eliminated by changing, respectively, the supply of cooking fuel and water. There are also serious gender and health implications of rural energy consumption patterns (Batliwala, 1982).

To understand the population implications of these features of energy consumption in villages, it is necessary to consider how these features influence the desired number of births in a family and the relative benefits and costs of fertility. A useful starting point is the general preconditions for a decline of fertility, as set forth by the demographer A. J. Coale (1973, 1983):

- Fertility must be within the calculus of conscious choice. Potential parents must consider it an acceptable mode of thought and form of behaviour to balance advantages and disadvantages before deciding to have another child.
- Reduced fertility must be advantageous. Perceived social and economic circumstances must make reduced fertility seem an advantage to individual couples.
- Effective fertility reduction techniques must be available. Procedures that will prevent births must be known, and there must be sufficient communication between spouses and sufficient sustained will, in both, to use them successfully.

The exercise of choice in matters of fertility is a culture-dependent issue, and awareness and availability of fertility-reduction techniques depend on specific technologies and the success with which they are spread. But the desired number of births, and therefore the relative benefits and costs of fertility, depend upon socioeconomic factors such as

- Infant mortality and the probability of offspring surviving. The lower this probability, the larger the number of children aspired to and the greater the exposure of the mother to the possibility of additional pregnancies.
- The role of women in arduous, time-consuming household chores. The greater this role, the smaller the scope and emphasis on women's education and the lower the age of marriage.
- The use of children to perform essential household tasks. The greater the use of children for these tasks, the more they become essential for the survival of the household.
- Opportunities for children to earn wages. Wage-earning children become desirable as economic assets.

Only a few of these factors enter into perceptions of advantages and disadvantages of fertility and family size. Nevertheless, the reduction of fertility, and therefore the acceleration of the demographic transition, depends on crucial developmental tasks. These tasks include an increase in life expectancy, improvement of the immediate environment (including drinking water, sanitation, and housing), education of women, and diversion of children away from household support tasks and employment to schooling.

Further, almost every one of these socioeconomic preconditions for smaller family size and fertility decline depends on energy-using technologies. Infant mortality has much to do with inadequate, unsafe supplies of domestic water and with an unhealthy indoor environment resulting from polluting fuel-stove cooking systems. The conditions for women's education become favourable if the drudgery of their household chores is reduced with efficient energy sources and devices for cooking and with energy-using technologies to supply water for domestic uses. The deployment of energy for industries that generate employment and income for women can also help delay the marriage age, which is an important determinant of fertility. And if the use of energy results in child labour becoming unnecessary for crucial household tasks (cooking, gathering fuelwood, fetching drinking water, grazing livestock), an important rationale for large families is eliminated.

From this standpoint, it is obvious that prevailing patterns of energy consumption in villages do not emphasise energy inputs for the following tasks:

- Providing safe and sufficient supplies of drinking water.
- Maintaining a clean and healthy environment.
- Reducing the drudgery of household chores traditionally performed by women.
- Relieving children of menial tasks.
- Establishing income-generating industries in rural areas.

Thus current energy consumption patterns exclude the type of energy-using technologies needed to promote the socioeconomic preconditions for fertility decline. In fact, they encourage an increase in the desired number of births in a family and an increase in the relative benefits of fertility (Batliwala and Reddy, 1996).

Traditional biomass-based cooking and demographic indicators

Traditional biomass-based cooking is predominant in most developing countries, particularly in rural areas. The negative health impacts of this are discussed in chapter 3. The low efficiencies of traditional biomass stoves derive from the incomplete combustion of the biomass, resulting in a number of health-damaging pollutants, particularly suspended particulates and carbon monoxide. These pollutants exceed acceptable levels inside poorly ventilated houses, especially those without chimneys. Thus one would expect to find a correlation between the percentage of biomass use in total energy use and a number of demographic indicators, especially those related to women and young children, who are thought to be most vulnerable.

Indeed, such a correlation has been revealed by recent work on a large number of developing countries (Bloom and Zaidi, 1999). Table 2.1 shows that, as the percentage of biomass increases, life expectancy decreases, infant (and child) mortality increases, and the annual population growth rate increases. Such trends do not prove causality but are consistent with the view that traditional biomass use impedes the demographic transition.

Energy-population nexus at the global level

One way of considering the energy-population nexus at the global level is through the 1 kilowatt per capita scenario (Goldemberg and others, 1985) described above. That scenario shows that, if the most energy-efficient technologies and energy carriers available today were implemented, a mere 10 percent increase in the magnitude of energy would be required for the populations of developing countries to enjoy a standard of living as high as that in Western Europe in the 1970s. In other words, under the conditions of this scenario, energy supplies need not become a constraint, and dramatic increases in living standards can be attained in developing

TABLE 2.1 BIOMASS USE AND DEMOGRAPHIC INDICATORS

Indicator	Percentage of biomass in total fuel use				
	0–20	20–40	40–60	60–80	Above 80
Number of countries	70.00	12.00	14.00	10.00	16.00
Female life expectancy (years)	74.70	68.80	62.00	56.10	48.30
Life expectancy (years)	71.50	66.50	59.90	54.50	47.00
Male life expectancy (years)	68.50	64.00	57.80	53.00	45.80
Infant mortality (per 1,000 live births)	22.50	46.60	64.70	82.60	116.80
Under-five mortality (per 1,000 live births)	27.50	59.30	93.00	135.30	173.00
Total fertility rate	2.51	3.26	4.64	5.35	6.33
Crude birth rate	19.20	26.20	35.00	39.10	45.00
Crude death rate	8.60	7.60	10.90	12.80	18.10
Annual population growth rate (percent)	1.00	1.61	2.43	2.74	2.52
Female-male life expectancy gap (years)	6.20	4.50	4.20	3.10	2.60

Sources: UN, 1993a; World Bank, 1998.

countries. It follows that, if energy-efficient technologies and modern energy carriers were implemented to enable the populations of developing countries to realise higher living standards, then these standards would likely result in low growth rates for developing country populations, similar to rates in Western European countries. Insofar as current energy strategies do not sufficiently emphasise energy-efficient technologies and modern energy carriers, they are not addressing directly the population problem.

Energy and urbanisation

A century ago, even visionaries could not imagine a city with more than 1 million inhabitants.[21] Yet by 2010 more than 500 such concentrations will dot the globe, 25 of them with more than 10 million people (so-called megacities). The availability of energy sources in combination with the phenomena of motorisation and industrialisation have substantially altered the manner in which people relate to their environment.

Urban dwellers will soon outnumber those in traditionally rural areas and constitute half the world's population. Of the 1.23 billion urban residents added to the world population since 1970, 84 percent have been in less developed regions. The global population is growing by 2.5 percent a year (3.5 percent a year in less developed regions, and 0.8 percent in more industrialised regions). The annual growth is 61 million people—roughly the equivalent of adding six cities with a population of 10 million to the urban population world-wide. By 2020–25 the global annual urban growth rate will have declined to less than 2 percent, but the urban population will increase by 93 million people a year—more than the current annual increase in the total world population.

The rate of urbanisation and its attendant impacts differ in regions across the globe. Thus strategies to capitalise on the positive factors of urbanisation and to mitigate the negative factors will also differ by region. Latin America is the most urbanised region in the developing world. Nearly three-quarters of Latin Americans live in urban areas. Although Africa is the least urbanised region, it is experiencing the highest urban growth rate, and already a third of its people live in cities. However Asia contains almost half the world's megacities and continues to urbanise rapidly. Given its current annual growth rate, Asia's urban population is expected to double in less than 20 years.

Increasingly, larger portions of the world's people live in the biggest cities. In addition, more live in intermediate-sized cities than ever before. In 1950 there were 83 cities or urban areas with more than 1 million people. Today 280 such urban areas exist. The growth of large cities also affects smaller cities, particularly in less developed regions. Over the next 15 years the number of cities with 5–10 million residents will increase significantly. Further, the number of people in them will more than double, as will the population of cities in the 1–5 million and 0.5–1.0 million ranges. This means that while megacities are the most visible symbols of problems and challenges, smaller cities are no less significant.

Urbanisation reflects more than demographic change. It is both driven by and profoundly influences the context and processes of development. It exerts both direct and indirect advantages in the struggle towards global sustainability and human development. The origins of many global environmental problems related to air and water pollution are located in cities—this is the urbanisation-pollution linkage. Unsustainable consumption and production patterns are also a feature of cities. But it is also in cities that one can find potential solutions, because they have several positive features.

Birth rates are three to four times lower in urban areas than in rural areas, thereby reducing environmental pressures from population growth. Cities provide greater accessibility to education, services, and training. They increase the access of residents to information on environmental issues and facilitate their integration into the policy process according to identified needs and priorities. Because of their concentrated form and efficiencies of scale, cities offer major opportunities to reduce energy demand and minimise pressures on surrounding land and natural resources. Women are also the direct beneficiaries of urbanisation, because their interests and demands are more easily articulated and negotiated in their new, dynamic social environment.

Cities are the engines of economic growth and centres of employment and opportunity for expanding and diversified national economies. Eleven of the twelve urban agglomerations with 10 million or more people are located within one of the 25 largest economies. The economic prosperity of nations will depend on the performance of their cities. With a focus on cities, appropriate energy policy can be targeted more effectively and resources leveraged far more efficiently to affect large numbers of individuals, communities, industries, and services. But a lack of competent and accountable urban governance can lead to the loss of much of the potential contribution of cities to sustainable economic and social development and, at worst, to a completely dysfunctional living environment. Concerned and innovative urban development planning, on the other hand, can enable growing urban populations to contribute towards sustainable human development by empowering individuals to convert their creative assets into global wealth.

Urbanisation and energy linkages

The 1996 United Nations Conference on Sustainable Human Settlements, known as Habitat II, reaffirmed that the vast majority of population growth in developing countries will occur in urban centres. The type and scale of urban development will largely affect future energy consumption. In turn, urbanisation also has a profound effect on the amount and type of energy consumed. Other factors—including economic development, industrialisation, and such social-cultural particularities as consumption patterns—also drive the global increase in energy demand. Although traditional rural societies rely heavily on human and animal energy and on wood for fuel, today's urban societies rely primarily on fossil fuels and electricity.

Per capita energy consumption remains low in the developing world. For many urban Africans and Asians, biomass fuels meet a large portion of energy needs. As these countries urbanise, energy demand increases, and traditional bulky fuels (such as wood and charcoal, which require energy-intensive forms of transportation), food, and other materials consumed in urban areas must be transported across greater distances. Urban manufacturing and industry also require more energy than traditional agriculture. In addition, the provision of infrastructure and services to new urban residents requires energy that is not typically consumed in rural settlements.

The new millennium is ushering in a new urbanised era. For the first time ever, more people will reside in urban settlements than in rural.

Urbanisation imposes enormous demands on the ecosphere, because most urban activities at the industrial, community, and household levels are based on natural capital depletion. Housing construction, transportation, economic activities, and the generation of residential heat and electricity all put stress on the environment and compete for ecological space. Energy use is already high in industrialised countries and is increasing rapidly in developing countries as they industrialise. But energy can be an instrument for sustainable development with an emphasis on more efficient use of energy, and an increased use of renewable energy sources, among other measures.

Urbanisation and energy strategies

Although many countries prepared national plans of action for Habitat II, most did not formulate a national policy on the linkages between urbanisation and energy. Few governments have allocated significant resources to encouraging more effective use of non-renewable energy resources or to increasing the long-term supply of renewable energy resources. In light of current urbanisation trends and the opportunities presented by new energy-efficient technologies and processes, the moment is opportune for this discussion to take place.

Cities have the potential to be far more environmentally benign. The spatial concentration of humans and their activities can minimise pressures on surrounding land and natural resources. Well-designed cities can channel development far away from wetlands and other sensitive areas, and protect natural resources. By integrating land-use and transportation planning, cities can reduce both congestion and pollution.

Cities offer important opportunities for protecting the environment. With proper planning, dense settlement patterns can ease pressures on per capita energy consumption and provide opportunities to increase energy efficiency. For example, recycling becomes more feasible due to the large quantities of materials and the number of industries that can benefit from it. In addition, land use, infrastructure, and services are better used, and the need for extensive transportation networks and residential heating is reduced. Low-density communities tend to have the opposite characteristics.

Transportation. Mobility and access remain among the greatest challenges for cities in the developing world, especially considering the growing proportion of lower-income people. A city that cannot be accessed by all its inhabitants is not sustainable. Because motor vehicle ownership remains relatively low in many of these cities, there is a window of opportunity to avoid the mistakes made in the industrialised world and design urban transportation systems that facilitate walking, bicycling, and public transportation. Such measures can improve the environmental health of cities and citizens as well as mitigate the threat of global warming.

Cities are centres of employment, residence, and leisure, and of the integration between them. Mobility and access are therefore complementary aspects of the same problem. Mobility implies movement: people going to work, people going to the market, people bringing vegetables to sell in the market. Access implies the ability to take advantage of urban functions: people developing 'backyard industries', people being able to find in their neighbourhoods the services they need, people being able to walk to work. A sensible balance between mobility and accessibility concerns should result in a more energy-efficient transport strategy based on demand management. In this regard, the systemic integration between land use and transport is much more important than an isolated concern with vehicles, fuels, and emissions. These are also important complementary concerns.

To illustrate, given the opportunity to work legally at home (for example, inputting data or transcribing reports from remote places), the informal sector, a thriving and integral sector in developing economies, would be formalised and backyard industries would proliferate, reducing the need for urban residents to commute to places of employment. The integration of sustainable transport and employment-related strategies could reduce stress on the local environment, promote more creative employment options (especially for women), and lead to a general improvement in quality of life.

Patterns of energy consumption also depend on the means and availability of transport. Where extensive road networks, vehicles, and other transport infrastructure exist, there is a high risk of depending on a supply-driven vicious circle. As is well known, conventional traffic planning based on individual modes of transport can lead to potentially difficult situations, as has occurred, for example, in Bangkok (Thailand), Kuala Lumpur (Malaysia), Mexico City, and São Paulo (Brazil). The creation of appropriate land-use legislation for residential and commercial sites and access to public transportation services can mediate the demand for more energy-intensive transport use.

Considerable opportunity exists to design more efficient transportation systems and create more liveable cities. A critical step for industrialised and developing countries is to move towards managing urban travel demand rather than simply increasing the supply by reducing or averting over-reliance on the privately owned car through appropriate pricing, spatial settlement policies, and regulatory measures.

A number of strategies are available to governments to advance a sustainable transport sector (Rabinovitch, 1993; UN, 1996):

- Exploration of surface (rather than above-ground or underground) solutions based on affordable technologies. Buses should be considered before a high-technology rail system.

- Development of an integrated transport strategy that explores the full array of technical and management options and pays due attention to the needs of all population groups, especially those whose mobility is constrained because of disability, age, poverty, or other factors.
- Coordination of land-use and transport planning to encourage spatial settlement patterns that facilitate access to basic needs such as places of employment, schools, health centres, and recreation, thereby reducing the need to travel.
- Encouragement and promotion of public access to electronic information services and technology.
- Promotion, regulation, and enforcement of quiet, use-efficient, low-polluting technologies, including fuel-efficient engine and emission controls, fuel with a low level of polluting emissions, and other alternative forms of energy.
- Provision or promotion of effective, affordable, physically accessible, and environmentally sound public transport and communication systems that give priority to collective means of transport, with adequate carrying capacity and frequency to support basic needs and reduce traffic flows.
- Exploration of partnerships with private-sector providers. Ideally the public sector should provide monitoring and operational standards, and the private sector should invest in capacity and contribute managerial comparative advantages and entrepreneurship.

Construction. Low-energy building materials such as timber, soil, sand, and stone require little energy in their manufacture and processing. The durability of many of these materials can be improved without large energy expenditures. These materials are often used in the construction of housing in developing countries. It is often possible to improve the use of such materials through appropriate construction methods and design techniques that maximise their functionality and natural advantage.

One example is construction using earth, in which the mechanical energy required is ultimately much more efficient than that for ceramic building materials, which require large amounts of heat (usually applied inefficiently). The low costs of locally available renewable energy resources could potentially ensure a continuous supply of energy to meet the demand of domestic, agricultural, and small-scale industrial sectors. These materials also have the advantage of being familiar to local building operators and planners.

Energy to improve the urban environment

The new millennium is ushering in a new urbanised era. For the first time ever, more people will reside in urban settlements than in rural. Perhaps the forces of change—economic, social, technological, and political—render this process inevitable. If so, policy design and prescriptions should be targeted differently. Rather than attempting to arrest rural-urban migration, it is important to make rural life less difficult and arduous and more pleasant and attractive. Energy interventions can play a positive role in this task through electrification of homes for lighting, labour-saving appliances, and entertainment, as well as for the supply of safe piped water. Thus an improvement in the quality of rural life can decrease the negative aspects of urbanisation, making it wise to pursue balanced urban and rural development and to ensure synergies between the two. The focus of development efforts should be redirected towards achieving more sustainable urban and rural living environments in light of the inevitability of a mostly urban world.

> The rapid expansion of urbanised areas, especially in developing countries, creates a unique opportunity to implement 'leapfrogging' approaches.

Rapid urbanisation is associated with a rise in energy demand—which potentially threatens the sustainability of human settlements and the natural environment. The spatial concentration and diversification of human and economic activities hasten the demand for resources and compromise the carrying capacity of final disposal systems and infrastructure. In addition, the rise in disposable income of urban populations is likely to lead to a concomitant desire for more material goods and services.

Yet many of the negative effects of urbanisation can be mitigated through innovative energy policies. In developing countries rapid urbanisation and its attendant demands on material and financial resources have severely compromised the ability of governments to foster sustainable environment. Although the use of fossil fuels in industrial processes, heating, electricity, and motor vehicles tends to expand with economic growth, measures can be taken to promote renewable, clean technologies that lessen the burden of economic activity on human populations and ecosystems. In cities in industrialised countries, control of motor vehicle emissions has led to a dramatic reduction in ground-level ozone and carbon monoxide levels on or near major roads.

Urban areas offer enormous potential for easing the demand for energy-intensive materials and increasing the efficiency of resource use. The agglomeration of social networks fosters an environment that is more accessible to public awareness campaigns, creating a favourable learning environment for changing wasteful patterns of consumption on a large scale. The application of new energy-efficient technology is more easily accelerated in an urban setting because business and industry may be more amenable to experimentation and thus bypass the environmentally deleterious path of excessive technological use that has often been followed in industrialised countries.

Most technologies used in cities in the industrialised world were invented about a century ago. The rapid expansion of urbanised areas, especially in developing countries, creates a unique opportunity to implement 'leapfrogging' approaches. Widespread urbanisation may provide the economies of scale needed to implement innovative affordable technologies.

The urban environment is also conducive to offering education opportunities and creating jobs. This facilitates capacity-building efforts to deal with the operation and maintenance of environmentally friendly energy infrastructure based on renewable sources. Opportunities for reducing the material inputs of production by recycling waste by-products are more feasible in urban areas. For urban services such as transportation, a reduction in cost and in the share of energy-intensive services provides an additional means by which energy strategies can take advantage of the positive aspects of urbanisation. A prime example is the promotion of surface bus modes of transportation rather than expensive solutions such as subways.

Energy and lifestyles

After the oil shocks of the 1970s, one of the issues that often arose in discussions of energy was the sustainability of a world with glaring and grave disparities in per capita energy consumption between industrialised and developing countries. A related issue was the need for convergence in per capita consumption through minimisation, if not removal, of these disparities.

These discussions were set aside because of optimists' belief in the enormous potential of efficiency improvements. These improvements—it was believed—would enable industrialised countries to sustain their energy services (and therefore living standards and lifestyles) with far less energy consumption. At the same time, the improvements would enable developing countries to achieve dramatic improvements in their standards of living with only marginal increases in their inputs of energy. Now, almost 30 years after the oil shocks, the time has come to revisit these fundamental issues by analysing the experiences of industrialised countries.

Energy use in the United States

Consider the United States.[22] Following the oil shocks and for almost 10 years, from 1973–83, the United States reduced its consumption even as its population and economy expanded. "Americans learned to do more with less" (Myerson, 1998). For instance, there was an emphasis on thicker insulation and tighter windows to cut space-heating bills. Compact, fuel-efficient cars became popular. There was investment in more efficient appliances, machines, and engines. As a result per capita residential energy consumption fell by a tenth. It looked as if energy patterns were following the hopes of the optimists.

But during the next 15 years, from 1983–98, the United States lost all the gains in energy conservation it achieved in 1973–83. Declining energy prices offset the conservation gains. In 1983–98 per capita residential energy consumption rose by 10 percent, offsetting its 10 percent reduction from 1973–83 and rising to within 2 percent of its 1973 peak. Americans returned to consuming nearly as much energy as before the oil shocks.

In 1999 Americans were expected to burn more fuel per capita than in 1973. U.S. dependence on oil imports has increased—in 1973 imports were 35 percent of consumption; in 1998, 50 percent. In 1973, 5 percent of oil imports came from the Gulf; in 1998, 10 percent. The reduction in the energy intensity of the U.S. economy has tapered off; from 1972–86 energy per unit of GDP fell 43 percent; but from 1987–97 the fall was only 8 percent. It appears as if, to one-third of Americans, "conservation means doing less, worse or without, i.e., privation, discomfort and curtailment" (Myerson, 1998).

Houses. The number of people in the average U.S. household has shrunk by one-sixth, but the area of the average new home has grown by one-third. In 1973 the average new home was 1,600 square feet for the average family of 3.6 people; by 1998 the average size had increased to 2,100 square feet even though the average family had shrunk to 3.0 people. In addition, many energy-intensive changes have taken place inside the home. For example, the average ceiling height, which was 8 feet in 1973, had risen to 9 feet by 1998. Ceilings are often so high that ceiling fans are required in winter to blow back rising heat.

Appliances. The penetration of energy-intensive appliances has increased. For example, in 1973 fewer than 40 percent of homes had central air conditioning. But in 1998 more than 80 percent had it. Forty percent of homes had two or more television sets in 1970; by 1997, the percentage was 85 percent. And homes with dishwashers increased from 19 percent in 1970 to 57 percent in 1996. There has also been an invasion of new always-on, electricity-sucking 'vampires' such as computers, videocassette recorders, microwave ovens, and telecommunications equipment. The energy consumption of these gadgets is rising 5 percent a year, and they will soon consume more per household than a refrigerator.

Transport. Americans are driving automobiles more than ever, primarily because there are more wage earners per family and more urban sprawl. The number of women working or looking for work increased from 47 percent in 1975 to 72 percent in 1997. Households with three or more cars increased from 4 percent in 1969 to 20 percent in 1998. From 1983–95 average commuting distance increased by one-third, from 9.72 to 11.6 miles. And only 15 percent of commuters use public transit.

Fuel-intensive minivans, sport utility vehicles, and pickup trucks are growing in popularity. As a result the average horsepower of motor vehicles increased from 99 in 1982 to 156 in 1996. It took 14.4 seconds to accelerate from 0–60 miles per hour in 1982, but only 10.7 seconds in 1996.

Gasoline prices are a key factor in these developments. The 1973 per gallon price (adjusted for inflation) was $1.10, but the 1998 price was only $1.00. U.S. gasoline prices are only about a third of those in Europe and Japan. No wonder U.S. per capita consumption is much higher than that in Europe and Japan.

Industry and commerce. U.S. corporations have all but stopped making improvements solely to save energy. Industrial and commercial energy use fell 18 percent from 1973–83 but rose 37 percent from 1983–97.

Environment. Clearly, energy prices and environmental concerns point in opposite directions. At the 1992 Earth Summit, U.S. President George Bush pledged to reduce carbon emissions by 7 percent between 1990 and 2010. But the U.S. Energy Information Administration predicts that emissions will rise 33 percent. If fears of global warming are justified, it looks as if the pattern of U.S. energy consumption during the past 25 years has grave implications for the global environment—even though U.S. national and urban environments are much cleaner.

While some saturation effects occur, lifestyles in industrialised countries still evolve towards higher levels of energy use.

Energy and income. How have changes in lifestyle influenced the pattern of energy use in industrialised countries?[23] What are the determinants of energy consumption? What are the driving forces of energy consumption patterns?

The general relationship between per capita GDP and per capita energy use has been established in many studies (Nakićenović and John, 1991). The relationship is non-linear—energy use typically grows slower than GDP. For instance, in 1985–95 per capita GDP in OECD countries grew 1.6 percent a year, whereas per capita energy use grew 0.8 percent (IEA, 1997).

It is instructive to look at energy use from the point of view of individual consumers or households. Households use energy directly (for example, electricity, natural gas, and gasoline) as well as indirectly, in the goods and services that they purchase. The sum of direct and indirect use represents the total energy requirements of a household. If it is assumed that, in the ultimate analysis, all products and services of society are produced for the service of households, then an overall picture of the energy requirements of society can be obtained.

The relationship between household income and energy requirements (using input-output analysis) has been known for a long time. In the early 1970s it was found that, if the income of households increases by 1 percent, their use of energy increases by 0.7–0.8 percent—that is, the income elasticity of energy requirements for any year lies between 0.7 and 0.8 (Roberts, 1975). More detailed research in the Netherlands using a combination of process analysis and input-output analysis came to similar findings; for 1990 the income elasticity of energy requirements was 0.63.

The most salient finding is that income is the main determinant of energy consumption. Other household characteristics, such as size, age of oldest member, life-cycle phase, degree of urbanisation, education level, and so on, turn out to be relatively unimportant (Vringer and Blok, 1995; Vringer, Gerlach, and Blok, 1997).

Income elasticity is smaller than unity because the growth of direct energy consumption is less than the growth of income. In contrast the indirect part of energy consumption grows in proportion to income. Thus a shift to less energy-intensive products does not take place as household income grows.

In the case of direct energy use, saturation effects occur. Lower-income households already use a large amount of natural gas (or other energy carriers for space heating). Gasoline consumption saturates at a much higher income level. Electricity consumption did not saturate in the income categories considered.

A cross-sectional analysis for 1948–96 yielded similar results. Indirect energy use grew at a rate more or less proportional to income. Direct energy consumption shows a different behaviour; from 1976–96 it grew at less than average income levels (Vringer and Blok, 1995).

Thus the lifestyle issue becomes an income issue. Seen from the perspective of households, income is by far the main driver of energy requirements. There does not seem to be any tendency to adopt less energy-intensive consumption patterns with rising incomes.

Trends towards increased energy use

Increasing income levels tend to lead to a higher use of energy services by citizens of modern society. Some saturation effects occur, but they do not have a dominant effect on energy consumption. The effects of energy-efficiency improvements, especially in space heating and large appliances, may be more important. Nevertheless, lifestyles in industrialised countries still evolve towards higher levels of energy use.

Many of the driving forces described here cannot easily be altered to lead to lower energy use. But energy-efficiency improvement (including design that stimulates energy-efficient use of equipment) had a considerable impact in the early 1980s. Hence increasing the rate of efficiency improvement seems to be the most straightforward approach to limiting the growth of energy consumption.

If it is necessary to go beyond the limits of efficiency improvements, it is not sufficient to identify income as the determinant. After all, one cannot look for income reduction strategies. But income is only a proxy for more fundamental determinants of energy use. Income is translated into consumption, which is the material expression (more appliances, bigger homes, heavier cars, more goods) of lifestyles. If one takes these material expressions as determinants, one can think of strategies directed towards altering the consumption patterns associated with the most energy-intensive categories of energy use without impairing quality of life. But a great deal of thought and action will be required to influence lifestyles in this way. They may require a fundamental change in current pricing and taxing policies—not to mention taking advantage of the Internet revolution to change trends.

Conclusion

This chapter has clarified the two-way linkages between energy, on the one hand, and poverty, women, population, urbanisation, and lifestyles, on the other. The relationship between energy and these major global issues is dialectical—the global issues determine energy consumption, and in turn, energy systems influence the issues. If attention is focussed on the global issues as the cause, then energy becomes the effect. But if the focus is on energy as the cause, then one can see the myriad ways in which energy shapes the global issues.

It has also been shown that current energy consumption patterns are aggravating various global problems, leading to further unsustainability. But energy can also contribute to the solution of problems; in particular, poverty, the situation of women, population growth, unplanned urbanisation, and excessively consumptive lifestyles. To realise energy's enormous potential in these areas, it must be brought to centre stage and given the same importance as other major global concerns.

A goal is an objective to be achieved, a strategy is a broad plan to achieve the goal, and a policy is a specific course of action to implement a strategy. Policies are implemented through policy agents working with policy instruments.

The goal for energy systems is sustainable development. Energy strategies to advance this goal should be derived from the details of the linkages between energy and social issues. In particular strategies should emerge from the manner in which energy can contribute to the solution of social problems.

Thus poverty alleviation in developing countries should involve the energy strategy of universal access to adequate, affordable, reliable, high-quality, safe, and environmentally benign modern energy services, particularly for cooking, lighting, income generation, and transport. Poverty alleviation in industrialised countries requires the energy strategy of universal protection and maintenance of access to affordable energy services, particularly for space heating and lighting.

Improvement in the position of women requires energy strategies that minimise, if not eliminate, arduous physical labour at home and at work, replace traditional biomass-based fuel-stove cooking systems with modern (preferably gaseous) fuels and cooking devices, and use the intrinsic managerial and entrepreneurial capabilities of women in decentralised energy systems.

Control over population growth can benefit from energy strategies that increase life expectancy and reduce infant (and child) mortality in developing countries through modern fuels and cooking devices that render unnecessary the physical labour of children for household chores such as gathering fuelwood, cooking, fetching drinking water, and grazing livestock—and that improve the quality of life of women.

Accentuating the positive aspects of urbanisation and alleviating its negative aspects require energy strategies that exploit the advantages of high-density settlements, provide universal access to affordable multi-modal public transportation, and reduce the 'push' factor in rural-urban migration by improving energy services in rural settlements.

Finally, reducing energy consumption through lifestyle changes requires a strategy—using pricing and taxation—of discouraging the use of energy-intensive devices and encouraging the use of energy-conserving devices.

To be successful, the strategies outlined above must harness both appropriate supply and end-use technologies. The strategies must also be converted into policies wielded by policy agents through policy instruments. Complete hardware plus 'software'—policies, management, financing, training, institutions—solutions are essential for the deployment of energy as an instrument of sustainable development. These challenges will be discussed in the chapters that follow. ■

Notes

1. Self-reliance does not preclude imports and exports but requires that control over destiny be indigenous.

2. Energy use is taken as a proxy for useful energy, which means that the efficiency of energy use has been held constant.

3. The linkages between energy and security, between energy and economics, and between energy and environment are dealt with in later chapters.

4. This section is based on inputs from Anton Eberhard and Wendy Annecke of the Energy Research Development Centre, University of Cape Town, and from David Bloom, Harvard University.

5. Unfortunately, estimates of absolute poverty are quite sensitive to the methods used to make these adjustments. In addition, all such methods focus on the cost of a standardised bundle consumed by an average household, not on the typical bundle consumed by a poor household. Insofar as market baskets consumed by poor households tend to be filled with relatively high proportions of less costly non-tradable goods and services, absolute poverty will be overstated with all methods of estimation.

6. This number has been adjusted for differences in the purchasing power of different national currencies in 1985 using estimates contained in Penn World Table 5.6 (Center for International Comparisons at the University of Pennsylvania, 2000).

7. Because of irregularities in supply, price rises, and so on, households have, in addition to a preferred or dominant fuel, other fuels as back-ups. Thus when LPG, for instance, is in short supply, households may be forced to switch to electricity.

8. The thought experiment was not intended to recommend Western European living standards as the goal for developing countries or to establish activity level targets for these countries to be achieved by some particular date. The appropriate mix and levels of activities for the future in developing countries will have to be different to be consistent with their climate, culture, and development goals. Rather, the purpose of the thought experiment was to show that it is possible not only to meet basic human needs but also to provide improvements in living standards that go far beyond the satisfaction of basic needs, without significant increases in per capita energy use. Thus energy supply availability need not be a fundamental constraint on development.

9. The correspondence between the 1 kilowatt per capita increase (about 30 gigajoules per capita annually) and a vastly improved standard of living is not very different from the threshold of 1 tonne of oil equivalent per capita (about 40 gigajoules per capita annually), above which infant mortality, illiteracy, life expectancy, and fertility all show substantial improvement and saturation (see figure 2.1).

10. This section is based on the paper prepared for this chapter by Jamuna Ramakrishna, Humanist Institute for Cooperation with Developing Countries (HIVOS), Bangalore, India.

11. The initial (early 1970s) belief that this degradation was the result of villagers' dependence on biomass for cooking has given way to a broader understanding that includes factors such as urban demand for biomass, industrial needs, logging, and clearing for agriculture. The fact remains that biomass cover (indicated, for instance, by remote sensing) is decreasing.

12. Under the criteria set forth in the 1993 revision of the SNA, the boundary between productive activities that are market-oriented and those that are not is drawn in such a way that the majority of household work and community voluntary work is excluded from the SNA. Education is also excluded. Although this leads to a gross underestimation of women's economic contributions, the 1993 revision is actually an improvement over the previous version of the SNA, which excluded production of household goods for own consumption and activities such as carrying water (UNDP, 1995).

13. This section is based on the paper prepared for this chapter by Jamuna Ramakrishna, HIVOS, Bangalore, India.

14. Total fertility is a measure of the average number of children a woman will bear throughout her child-bearing years if at each age she has the average fertility corresponding to that age group.

15. Incidentally, the growth in the percentage of the working-age population capable of being economically active (relative to the total population) has been ascribed a key role in the East Asian economic miracle in conjunction with educational, health, and institutional measures to realise the economic potential of this boom in the labour

force. Thus the middle phase of the demographic transition has important implications for economic growth.

16. The importance of the percentage of working-age population was brought out by Bloom and Williamson (1998).

17. The 'demographic indicators for countries of the world, 1950–2050, medium variant' (UN, 1996) estimates 9.37 billion in 2050.

18. Data are from John Holdren, Harvard University.

19. In one of the villages studied, fuelwood consumption corresponded to about 217 tonnes of firewood per year; that is, about 0.6 tonnes per day for the village, or 0.6 tonnes per year per capita.

20. Unlike in some rural areas of India, dung cakes are not used as cooking fuel in the region studied. In situations where agro-wastes (such as coconut husks) are not abundant, it appears that, if firewood is available within some convenient range (determined by the capacity of head-load transportation), dung cakes are never burnt as fuel. Instead dung is used as manure.

21. This section is based on the paper prepared for this chapter by Jonas Rabinovitch, senior urban development adviser, UNDP, with the assistance of Raquel Wexler.

22. Apart from information provided by the U.S. Energy Information Administration, an excellent article is Myerson (1998).

23. This section is based on the input of Kornelis Blok, Utrecht University.

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