Issue Paper on

Environment, Energy and Cities: Issues, Problems and Strategic Options for Urban Settlements of the Developing World

Introduction:

Energy is a key input for meeting basic needs and for achieving socio-economic development goals that include, inter-alia, fuel for cooking, heating and lighting in households, power for industry, and petroleum products for transportation. The supply of and the demand for virtually every type of energy generates varying degrees of environmental externalities that affect human health, ecological stability,and economic development. These effects can occur at the local, regional, national or transnational level.

Cities, with their high population densities, tend to concentrate environmental problems that elsewhere, are otherwise geographically dispersed. A classic example of this is air pollution in cities where both point (e.g. industrial emissions from smokestacks) and nonpoint (e.g., vehicle exhaust) sources are concentrated in a limited, densely populated geographic area. The degree of the problem varies with prevailing winds and thermal stratification patterns, urban geography, levels of industrialization and motorization, and the incidence of indoor as well as outdoor human exposure. It is important to note that the cause of many of these problems may be urban but the impact can be felt both inside and outside the city. In addition, ambient air pollution may affect the health of urban residents and damage the crops n of farmers in rural areas.

Urban areas in developing countries typically generate up to fifty per cent, and often more, of the national gross domestic product. This involves the consumption and transformation of energy resources that are not found within the physical limits of the city. Urban energy demand and consumption are the source of environmental problems in the hinterland. Examples include: (a) peri-urban deforestation, which is exacerbated by household, industrial, and commercial consumption of woodfuels; (b) extra-urban air pollution and crop damage due to acid rain emanating from coal-fired power plants; and (c) Siltation, spread of disease vectors, reduction of habitat, and loss of biological diversity caused by construction of dams to provide hydroelectricity to the primarily urban-based power grid. These constitute an environmental shadow cast on rural areas by urban energy use.

The share of the developing world's population Jiving in cities is expected to rise from 32% in 1985 to 40% (2000) to 57% (2025).[1] This growth fuels demand for energy in all sectors of the urban economy and partially explains why LDC energy demand is projected to rise from current consumption of one-third of that of OECD countries to parity with OECD demand by the year 2015. A recent World Bank study[2] concludes that the main factors contributing to increases in

[1] UN-HABITAT Human Settlements Data Base

[2] Imran, Mudassar and Philip Barnes "Energy Demand in the Developing Countries: Prospects of the Future, "World Bank Commodity Working Paper Number 23, August 1990.

commercial energy consumption in LDCs are increased levels of motor vehicle use and urbanization. This increased fuel consumption is bound to exacerbate urban-based pollution. One consequence of this growth in demand for commercial fuels is that related environmental impacts will also increase if no mitigating measures are introduced. These effects will be increasingly felt all the way from the neighbourhood to the global level.

At all levels (production, transformation, and consumption), urban energy use is a commercial activity, whether it is power generation for use by urban-based industries, refining of petroleum products, or neighbourhood sales of kerosene for household lighting. In cities, even these traditional types of fuel such as wood or charcoal, are bought and sold[3]. The implication for environmental management is that it is much easier to use economic policy instruments to influence energy consumption where there is a market, i.e., in the city.

The relevant programme area on "Promoting sustainable energy and transport systems in human settlements" of Agenda 21, in its basis for action states that "most of the commercial and non-commercial energy produced today is used in and for human settlements, and a substantial percentage of it is used by the household sector. Developing countries are at present faced with the need to increase their energy production to accelerate development and raise the living standards of their populations, while at the same time reducing energy production costs and energy-related pollution. Increasing the efficiency of energy use to reduce its polluting effects and to promote the use of renewable energies must be a priority in any action taken to protect the urban environment." The urban sector, being the dominant sector of commercial energy use and a major sector in the use of biomass fuels, will have to take a leading role towards increasing energy efficiency. This will require major policy changes from "business as usual" to imaginative innovations in lifestyle, energy use and energy policy planning to re-orient the current focus on energy supply to an end-use oriented approach, and thus contribute to the sustainable human settlements development goals established by the Agenda 21.

I. The structure of Urban Energy Use and its Environmental Implications

An energy balance i.e., share of different types of energy sources by sector, in total energy use, usually prepared for an entire country, presents data on the types of fuels being used by different sectors of the economy. Increasingly, these balances are being prepared for developing cities. However, there is no "typical n urban energy balance, and it would be difficult to calculate an average one due to the limited number of balances that have been prepared to date. Nevertheless, reviewing an energy balance is a useful first step in understanding a city's energy/environment

[3] UN-HABITAT, Energy for Low-income Settlements (HS/245/91E)

problems. In Delhi[4], the energy balance indicates that households are, by far, the most important consumers of fuel, and that their key sources of energy are petroleum products (kerosene and PG) and electricity; residential use of these fuels alone accounts for over 60% of the gross energy used in Delhi. Overall, electricity is the most important energy source; it is used extensively by households, industries, and commercial enterprises. Apart from focusing on the key fuels and sectors, an energy balance points out special features of each sector. For example, while charcoal accounts for only 8% of total gross energy consumption, it supplies 40% of the fuel used by industries in Delhi. In other cities, particularly those of sub-Saharan Africa, woodfuels constitute a far greater proportion of the balance and are primarily consumed by households. Unfortunately, without additional information, the balance is not sufficient to show the environmental issues linked to this pattern of energy consumption. For this, information is required about how fuels are provided to and I used in the city.

Understanding urban demand for energy requires specific information about end-uses and special factors affecting each fuel-consuming sector. As energy is an input to other processes, it is important to have information about these end-users of each fuel. An example of such information for the five principal cities of Senegal[5] shows that cooking with charcoal is the most important household use of fuel in these areas. Regarding the transport sector, a sample made of 15 developing countries revealed that, between 1970 and 1985, the annual rate of growth of oil use was 5.8 % , compared to 2.2% in OECD countries.[6] The number of passenger cars increased from 13 to 47 million between 1970 and 1988.[7] With this information, one could then proceed to examine the environmental risks associated with these end-use.

Factors affecting fuel switching

It is important to assess the factors that influence energy demand, especially in terms of demand management. In the residential sector, the key determinants of demand are: (a) the relative price of the energy form and the appliance that it will fuel, (b) The disposable income of the household, (c) the availability of the fuel and related appliance(s) in the market, (d) particular requirements related to each end-use, and (e) cultural preferences. In addition, urban household fuel consumption generally follows the "energy ladder"; The residents move from consuming less costly and less convenient fuels (wood, other biomass) to energy of intermediate price and quality (charcoal, kerosene) to more expensive, highly convenient types of energy (LPG, electricity), as their incomes

[4] Bose, R. K. “A Linear Programming Model for Urban-Energy-Environment Interaction in the City of Delhi,” PhD thesis, Indian Institute of Technology, Delhi, April 1990.

[5] World bank/UNDP “Senegal: Urban Household Energy Strategy”, ESMAP Report No.096/89, 1989

[6] Meyers S., Transportation in the LDCs: A Major Area of Growth in World Oil Demand, Lawrence Berkeley 1988, p.l.

[7] Lowe, M.D., Alternatives to the Automobile: Transport for Livable Cities, Worldwatch Paper 98, WorldWatch Institute, 1990, Table 1, p.8.

rise and/or habits change over time.[8] For example, a recent analysis[9] indicates that the choice of cooking fuels in Bangkok is highly correlated with the value of women's time. As more women enter the workforce, they demand more convenience in their use of household fuels, preferring LPG to more traditional forms of energy. The income effect is illustrated by survey results for urban households on Java.[10] The survey indicates that, for the poorest households, upwards of 10% of their expenditures go for fuel (primarily kerosene, with some wood and electricity), while the highest income quintile spends only about half as much, in relative terms, on energy (primarily electricity, with some kerosene and LPG). Another study[11] clearly brings out the relationship between income and fuel use: as purchasing power increased in urban areas of India, Pakistan, and Brazil, the use of biofuels declined.

An important consequence of the dynamics of the energy ladder is the shift in fuels used in developing cities (and their related environmental problems) in recent years. The consumption of energy for lighting, cooking, and appliances by households and the service industry has changed significantly: growth in household incomes and urbanization has been accompanied by a change in the fuel mix to energies that can be used more efficiently. As incomes and urbanization continue, the share of traditional fuels used in cities will diminish while modem fuel consumption will increase. This point is illustrated by a case study of South Korea. [12]The relative role of firewood as a percentage of total energy consumption declined rapidly between 1965 and 1980, with petroleum and electricity gaining in relative importance. Much of this transition was caused by the rapid industrialization and urbanization that took place during the same time period.

Urban transport

There is a lack of sound data on the share of urban travel in transport energy consumption in developing countries. There are, nevertheless, good reasons to believe that, given the concentration of motor vehicles in urban areas, this share can be close, to 50 per cent with the exception of vast but relatively less urbanized countries such as India, where it amounts to about 40 per cent. In the 80s, the level of car ownership was 8 times higher in Karachi than in Pakistan taken as a whole and ten times higher in Cairo than in Egypt taken as a whole, while Nairobi and Abidjan concentrated about 48 per cent and 67 per cent of cars registered in Kenya and Ivory Coast, respectively. This shows the importance of managing the supply of and demand for urban transport, including modal split in travel, for making it energy-efficient and environmentally sustainable.

[8] UN-HABITAT, "Use of energy by households and in construction and in production of building materials" (HS/C/13/80, Theme paper presented to the thirteenth session of the Commission on Human Settlements, Harare, Zimbabwe, 29 April – 8 May 1991.

[9] Tyler, Stephen. "Household Energy Use in Thailand Cities: The Influence of Value of Women's Time and commercial Activity." Report prepared for UNDP/World Bank ESNAP, December 1990.

[10] UNDP/World Bank "Indonesia: Urban Household Energy Strategy Study," ESMAP Report 107A/90, 1990.

[11] Gerald Leach and Marcia Gowen, " Household energy Handbook," World Bank Technical Paper No. 67, 1987.

[12]Kirk Smith, "The Biofuel Transition," in Pacific and Asian Journal of Energy, Vol.1 No. 1, 1987

The institutions and other players that influence urban energy use are also to be considered. On the supply side, the important actors are: utilities, the owners of energy resources, fuel transporters, government regulatory and pricing agencies, and wholesalers. On the demand side, the key players are: retailers, utilities, government regulatory and pricing agencies, producers of energy-using equipment (appliances, motors, boilers, etc.), and consumers (households, industries, the informal sector, commercial/services, and transport). The extent to which some of these actors operate in the private, informal, or public sectors will influence their interactions.

Environmental impact of urban energy supply

The impact depends upon the types of energy supply. In the case of wood and charcoal, deforestation is the impact at the regional level while health and safety are affected during the conversion process of biomass into charcoal. The supply processes of petroleum products and natural gas cause land degradation and sulphur emissions at the local level and land/sea spills at the regional level. The conversion processes can lead to global warming through CO_2 emissions.

The extraction and conversion processes of coal lead to water pollution, respiratory ailments and land degradation at the local level. Electricity generation from hydro affect river ecosystems at the regional level and displacement of populations, etc. at the local level. Nuclear energy generation leads to mine wastes at the local level and fuel cycle radiation at the regional level. Nuclear waste storage poses environmental threats that have local, regional and global connotations.

The impact of power plants located in urban areas, can be serious at the local level as a result of the emission of pollutants leading to deterioration of air quality and health hazards affecting concentrated population.

Despite the seemingly gloomy picture of deforestation, with economic growth, urban consumers usually make the transition from biofuels to commercial fuels, thus reducing fuel-related pressure on peri-urban forest resources. The change-over could be even more environmentally beneficial if power generation, industry and the transport sectors were to use natural gas.

Environmental impact of urban energy demand

Firewood, charcoal, coal and petroleum products all have negative environmental impacts due to emission of particulates, CO_2, CO, SO_2 at the household, neighbourhood, local and regional levels, depending upon the type of fuels. For example, in purely weight terms, the most important sources of emissions in Delhi are: CO from charcoal (used by industries), and from kerosene (households), and particulates from coal (used by industries). On the other hand, results from Ankara indicate that particulate and SO_2 emissions are primarily household-based, while hydrocarbons, NO and CO are vehicle-generated.

The dependence of urban transport on road motor vehicles fuelled by gasoline and diesel oil leads to increasing air pollution. Transport in developing countries contributes to about 30 per cent of the global transport-related emissions of CO_2, NO_x and hydrocarbons, and in much higher percentage to the emissions of lead, SO_x and diesel particulate. It has also about 20 per cent share in the emission of CO_2 - a gas mainly responsible for greenhouse effect. The problem of transport-related

air pollution in developing countries is still largely an urban problem confined mainly to large cities; by the 1980's, the concentrations of atmospheric pollutants commonly associated with motor vehicles often exceeded the WHO guidelines on ambient quality in many large cities such as Mexico City, Sao Paulo, Santiago, Cairo, Ibadan, Lagos and in nearly all megacities in Asia.[13]

In Mexico City, perhaps the city with the worst air pollution situation in the world, motor vehicles were responsible for the emissions of 99 per cent of carbon monoxide, 89 per cent of hydro carbons and 64 per cent of nitrous oxides by the end of 1980's.[14] In Bombay, according to data assembled by the Bombay Municipal Corporation, transport contributed to 63 per cent of the total air pollution in 1986, while its share was only 40 per cent in 1973. In Taiwan, in 1986, transport contributed to about 50 per cent of the emissions of hydro carbons, nitrogen oxides and carbon monoxide and above 10 per cent in sulphur oxides emissions.[15]

II. Issues and Options to meet the Urban Environmental Challenge

Household Level

At the household level, urban dwellers in many cities are exposed to excess levels of indoor air pollution, which results from the lack of proper ventilation and incomplete combustion of biomass, coal, and other fuels used to meet residential cooking and/or heating needs. Health effects include acute respiratory infection, low birthweight, and eye problems. Impacts vary greatly according to cooking practices, fuel use, type of dwelling and duration of exposure. The groups that are most at risk are women and children because they are indoors and responsible for cooking in most cultures. Short-term options to address this environmental health risk include: (a) production and dissemination of more efficient cookstoves that are more clean-burning, (b) installation of chimneys to vent smoke from dwellings, and (c) consumer education about the adverse health effects of indoor smoke inhalation. Longer-term approaches include the upgrading of kitchens and heating systems; formulating pricing policies that result in energy conservation and substitution of cleaner fuels for cooking and heating; and tackling other sources of indoor pollution such as cigarette smoke, hazardous chemicals, and radon.

Urban poverty strongly reinforces the social and environmental impact of energy use at the household level. A study of low-income groups in Rio de Janeiro suggests that the poor do not have adequate information about, or access to, more efficient (less-polluting) equipment and fuels. Furthermore, because the distribution network is less well-functioning or absent in the poorer sections of the city, those in poverty are served by a parallel market in which they pay more than the well-to do, making it more difficult to afford other available options. In addition, low-income

[13] Faiz, A., Sinha, K., Walsh M., Varma A., Automotive Air Pollution: Issues and Options for Developing Countires. The World Bank, Washington, D.C. 1990 pp. VII-X.

[14] Joumard R. Pollution de l'air due au trafic dans les pays en developpement, Revue de l'INRETS, No. 22, 1989

[15] Shu-Hung Shen, Kuang-Huei Huang, Response to Transport-Induced Air Pollutin: The Case of Taiwan, in: Driving New Directions: Transportation Experiences and Options in Developing Countries, The International Institute for Energy conservation, Washington, D.C. 1991, Table 2.2.

families often settle in undesirable (but affordable) sections of the city that may suffer from energy-generated pollution, e.g., near major roadways or factories. This increases their exposure to daily doses of pollutants as well as the risk of accidents.

Local Level

There are two important issues that need to be addressed at the local level. First, those concerned with energy and environmental matters in the urban context need to focus on problems where an identifiable population is exposed to a significant threat. For example, when comparing emissions rates from a large coal power station with those of smaller, decentralized woodburning plants, one needs to account for total output of pollutants and impact on affected population. The large central facility may be located in a remote, underpopulated, and well-vented- airshed while the n decentralized sources may be both more numerous and much closer to population centres, thus exposing a large number of persons to emissions. A recent study carried out in Bombay[16] shows a clear spatial/population nexus for energy-based environmental problems. This issue can best be resolved through an improved understanding of the Importance not only of volumetric measurements of pollutants but also their spatial locations, human health effects, and economic/environmental costs.[17], [18]

Second, there is an important conceptual issue that needs to be grasped by those focusing on energy-generated urban environmental problems. Specifically, environmental externalities do not exist in and of themselves; they are embedded in sectors and systems. For example, to deal with the environmental consequences of vehicle exhaust, it is necessary to examine the issue of cleaner fuels (reducing/eliminating lead in gasoline and sulphur in diesel), but also encouraging the use of energy efficient and clean vehicles, improving traffic management, improving public transportation, and developing a policy framework (regulatory, pricing, and taxation mechanisms) to reinforce these actions. A study of Mexico City[19] dealing with the transportation system in order to get at environmental externalities shows that, to reverse the steadily deteriorating situation, in 1990 the government launched a comprehensive program centering on improved transportation. This involves reducing the number of private cars, cleaning the gasoline produced in the country's refineries, and replacing the engines on 3,500 old diesel public buses.

Some of the key actions being introduced to reduce urban air pollution in Mexico City include:

- Requiring drivers to leave their cars home one working day per week;

- Setting emission standards similar to those in effect in California, in bidding documents for new bus engines;

[16] BMRDA Environment Cell, "Air Quality Status Report: Greater Bombay,"1987.

[17] UN-HABITAT, "Environmental Health and Human Settlements" in Habitat News Volume 13, Number 3, August 1991.

[18] UN-HABITAT, "The Role of Human Settlement and Improving community Health in Africa", paper presented at the International Conference on Community Health in Africa, Brazaville, Congo, 4-6 September 1992.

[19] Adapted from "Pollution: Two Cities, Two Solutions, "The Urban Edge, Vol. 14, No. 18, October 1990.

- Raising subway fares to cover the costs of the new bus engines as well as subway improvements;

- Rationalizing the routes of the 60,000 private mini-vans that carry passengers from low-density suburbs to the city centre;

- Hiking the price of gasoline by 12.5% and using ensuing revenues to fund the environmental Programme;

- Requiring that, by the end of 1990, all new vehicles sold must be equipped with catalytic converters; and

- Regulating that all vehicles be inspected twice a year to check auto emissions, with a monitoring programme to detect and penalize violations.

In addition, the programme involves tree planting, creation of new parks, substituting less-polluting fuels in power plants and other industries, and improving industrial efficiency.

Similarly, the integration of land-use and transportation planning can contribute to the alleviation of transport impact on the environment and reduce energy and land consumption by: (a) decreasing the demand for transport; (b) providing for distribution of this demand which limits congestion and increases efficiency in the use of transport infrastructure; and (c) supporting the use of energy-efficient and low-polluting transport modes.

The promotion of high-occupancy transport should also be high on the agenda, because of their lower energy consumption and emissions per passenger-km compared to cars.

Also given the energy and environmental advantages of non-motorized transport, and its social importance, there is the need to encourage non-motorized transport modes in urban areas.

Regional Level

At the regional level, land degradation is an important environmental impact that is often associated with urban consumption of biomass fuels. Meeting urban energy demand for firewood, charcoal, and crop residues can be an important source of rural income. However, it also contributes to deforestation, soil erosion, poor groundwater recharge, loss of agricultural productivity and, in some cases, desertification. Typically, these types of degradation are most severe within a given radius from the urban centre, and are often most immediate along major transportation axes. They cast what energy planners term an "urban shadow" over the peri-urban and rural environments. The issue directly involves low-income urban households because wood fuels are the dominant source of energy for these consumers, even in many middle-income developing countries, and especially in Africa. This may be " exacerbated in areas that are adversely affected by structural and other economic adjustments; in some instances, there has been downward mobility on the energy ladder, with consumers switching from modem fuels back to biomass because of declining urban incomes. For example, in sub-Saharan Africa, woodfuel demand grew by 3.1% per capita annually from 1975-85 while real GDP per person fell by 1.8% each year.

Options to address urban-driven land degradation include: (a) a variety of programmes to improve management of woody biomass resources; (b) dissemination of affordable improved carbonization methods that convert wood to charcoal at greater efficiencies than traditional methods, thus reducing demand on forest resources; (c) conservation measures in the urban informal sector to reduce woodfuel demand; (d) accelerated switching to affordable fuels, such as kerosene, liquefied petroleum gas I and renewables, which can substitute for woodfuels that are used by households, industries and the informal sector; and (e) economic pricing policies for woodfuels and equipment that encourage conservation and substitution. Again, when considering these options, one should examine the context of the problem. A caveat in this area is that energy demand is not, in some cases, the most important cause of land degradation. For example, an urban household energy strategy study for Zambia concluded that only 12 % of woodland clearing could be directly attributed to woodfuel production; the major cause of natural vegetation destruction in the urban biomass catchment areas was conversion to cropland.

Global Level

Globally t the consumption of energy in developing cities results in significant emissions of greenhouse gases. Energy-related activities contribute to half of the gases that are involved in global warming, with other industrial emissions, deforestation, and agriculture making up the remainder. Although developing countries emit 11 times less greenhouse gas emissions than developed countries, they accounted for 15 % of cumulative CO2 output between 1970 and 1986. However, with population growth and accelerated industrialization, developing countries will account for both greater per capita and overall output. Much of this will come from metropolitan areas where there is a concentration of vehicles, industries, peri-urban deforestation, and other causes of high emissions.

Three levels of options exist to reduce municipal outputs of greenhouse gases in the developing world; those that yield unambiguous economic benefits; those where the costs of action are low relative to the potentially high costs that might be incurred by doing nothing ("buying insurance"); and those where not enough is currently known to justify "buying insurance".

The options that fall in the first category are: (a) Pricing energy products to cover their economic costs, thus encouraging conservation; (b) Removing market imperfections that impede efficient energy use in households, industries, enterprises, transport, and the public sector; (c) Reducing losses in the supply of energy, e.g., generation, transmission, and distribution losses to urban electricity consumers; (d) Promoting the substitution of cleaner alternative fuels and technologies, e.g. crop residues for agro-industries and households, and natural gas in industry and transport; (e) Improving transportation systems through pricing, investment, technological options, and regulatory measures to reduce urban traffic congestion; and (f) Managing peri-urban lands to maintain green zones and increase forested areas that, through photosynthesis, are important sinks for CO_2.

The second rank of options includes phasing out of CFCs, many of which are found in energy-using appliances that are concentrated in cities (e.g. refrigerators, manufacturing processes, and air-conditioning systems), accelerated research into the commercialization of new/renewable energy technologies, sustainable use of biofuels, and implementation of a carbon tax.

Nuclear energy is a good example of the third rank of options that has been demonstrated to be too costly to qualify as insurance.

III. A Framework for Pursuing a Sustainable Path-putting Agenda 21 into Action

Recognizing that a comprehensive approach to human settlement development must include the promotion of sustainable energy development and use in all countries, the United Nations Conference on Environment and Development (UNCED) included, in its Agenda 21, a distinct programme area on "Promoting sustainable energy and transport systems in human settlements".[20] The objective of this programme is "to extend the provision of more energy-efficient technology and alternative/renewable energy for human settlements and to reduce negative impacts of energy production and use on human health and on the environment".

The Conference also recognized that resolving the conflict between development, transport needs, energy use and the environment require actions going far beyond the transport system itself. It was, therefore, emphasized that "promoting efficient and environmentally sound transport systems in all countries should be a comprehensive approach to urban-transport planning and management". This underscored the need to improve efficiency in transport operation, specially in the use of energy, but also the need to contain transport demand within sustainable limits.

The Conference identified the principal activities that must be undertaken by developing and developed countries together with the international community, to achieve the relevant objectives set out in Agenda 21.[21] These activities, taken together, constitute a comprehensive action plan with clearly defined responsibilities. The implementation of this action plan will, however, call for a broad-based consensus on the critical issues and a strong commitment to pursue the solutions with effective participation by all key actors.

Three key "pre-requisites" can be identified which are crucial to the successful implementation of the action plan set out in Agenda 21. These are:

***Understanding the problem**, with a view to improving policy-making and for building capacity to plan and implement responses to the urban environmental challenge;

***Establishing an enabling policy environment**, that takes into account the full range of issues and options, the special needs and abilities of those affected and the key actors, and provides an optimal mix of regulatory and incentive-based actions;

***Capacity-building**, based on an institutional strategy that mobilizes public support and broadens decision-making processes, and develops the managerial, technical and financial capacities of those responsible for the planning and implementation of actions.

[20] Programme area E Under Chapter 7, “Promoting Sustainable Human Settlements Development”.

[21] These activities are included in Chapter 9 (Protecting the atmosphere), programme area B, subprogramme 1 (Energy development, efficiency and consumption) and subprogramme 2 (Transportation); the principal activities related to human settlements have been summarized in chapter 7, programme area E (see Annex 1).

Understanding the problem: To improve policy making so as to better manage urban energy-use related environmental problems, planners and policymakers need informed analysis based on adequate data. For example, it is not enough to know qualitatively the energy-related environmental impacts in the urban sector. The magnitude and the significance of these impacts must be assessed and physical impacts will have to be converted into economic costs to assess which ones require priority attention.

The first step in such an analysis is to prepare an "energy balance" for the city. From this energy balance, it is possible to prepare an "air pollution balance" based on estimates for fuel emissions of pollutants from key fuels used by different sectors. With this information, the key sources of emissions within each sector can be identified for possible action.

Another area of research that needs attention is the estimation of economic costs of energy-related environmental impacts. While such estimates are available for industrialized countries, work needs to be done to determine the values for developing country cities.

To deal with transport-related pollution, some of the key areas that need to be explored are:

a) What are the environmental and health costs and economic benefits of alternative patterns of transport and land-use configuration?

b) What strategies for transport and land-use development could best achieve the objectives of environmental protection and energy saving?

c) What are the criteria for setting the standards for energy-efficiency and emission levels of vehicles in developing countries?

In addition to research and data collection on environmental conditions and impacts, education and information exchange would be important for effective environmental management. Policy makers at all levels of government must be I informed about the implication of their decisions, actions, or inactions on energy- related environmental issues.

Establishing an Enabling Policy Environment

Energy policy making will require a multidisciplinary perspective, incorporating urban, transportation, and health planning. Urban planning needs to incorporate the environmental dimensions of energy use in its analyses. How this is done in practice will vary depending on the municipal, regional, and national configuration of actors and institutional responsibilities. Regardless of where planning is sectorally located, decision makers should be clear about the environmental tradeoffs that are involved in policies and programmes that involve urban energy use.

Policies and programmes that permit improved energy efficiency will be an important first step in dealing with environmental problems stemming from urban energy use. By investing in efficiency, developing countries can stretch the energy services from existing supply capacities free up capital for needed investment in the sector, and reduce CO_2 emissions.

A serious obstacle to improving energy efficiency in the urban sector lies in the institutional structure of energy decision-making. Access to information and access to capital are not concentrated in the hands of energy users, but in the supply-side of the energy equation. Utilities make supply-side investment decisions, builders determine the appropriate level of building insulation, appliance manufacturers determine the energy efficiency of their products, and none of them pay the energy bill. Energy and product markets also fail to capture externalities, which are borne by others. This is a challenge that must be met by new and innovative policy initiatives.

Two other policy areas need special attention. The first concerns an environmentally desirable structural change in urban energy-use patterns. Pricing, as a policy instrument, has been used successfully in some developing countries to promote environmentally cleaner fuels like LPG in household-use and unleaded n gasoline in automobiles. At the same time, such subsidies have often been criticized for breeding inefficiency. Nevertheless, there is a growing recognition of the efficacy of incentive-based economic instruments for policy implementation. They can reduce excessive reliance on regulation and investment programmes to control pollution and stimulate innovation.

The second area concerns the promotion of renewable energy use in urban areas. A range of renewables hold promise here: solar, biomass, recycled agricultural wastes, and even garbage. Concerted action will be required at all levels to put renewables in the national energy matrix, but success will primarily depend on the abilities of developing countries to support private renewable-energy investors through selective and well-targeted subsidies, fiscal and other forms of incentives and innovative venture capital schemes to speed up commercialization of renewable energy technologies.

Building Capacity for Implementing Solutions:

Implementing urban environmental strategies to tackle energy-use related problems will require integrating environmental considerations into existing responsibilities, initiating new environmental actions or programmes that address critical problem areas and mobilizing financial resources to perform the related tasks.

It will be expedient for most cities to build on existing structures and capacities to meet new environmental responsibilities rather than developing new institutions or authorities. The principal capacity-building tools include training, technical assistance, private sector participation, public information and outreach programmes. A participatory approach with end-user involvement will be crucial to successful formulation, implementation and follow-up of projects and programmes.

For most developing country cities, capacity-building will be a long-term and dynamic process, refining and strengthening existing strategies, skills and capabilities. External assistance will be crucial in building the necessary capacity to plan and implement environmental strategies at local level. Principal areas where such support should be considered are: (a) environmental research and policy analysis needed to formulate urban environmental strategies and action plans at local level; (b) policy reform, institutional development and resource mobilization; and (c) financial support

for improving efficiency of urban energy services, and for the promotion of renewable energy technologies.