BIBLIOGRAPHIC DATA SHEET

PN-AAJ-101

ASSISTANCE TO THE THIRD WORLD ON URBAN ENERGY

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CORPORATE AUTHORS - OVERSEAS DEVELOPMENT COUNCIL

1980, 191P.

ARC NUMBER - 333.777.H856
CONTRACT NUMBER - AID/DSAN-G-0142
PROJECT NUMBERS - 9310003
SUBJECT CLASS - AP0000000000

DESCRIPTORS - URBAN AREAS
ENERGY CONSUMPTION
ENERGY
ENERGY NEEDS
DEVELOPMENT STRATEGY
METHODOLOGY

333.777
H856

PN-AAJ-101

ASSISTANCE TO THE THIRD WORLD ON URBAN ENERGY

A Report by

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May 19, 1980

TABLE OF CONTENTS

	Page
Acknowledgements	i
Introduction	1
Chapter I -- The Role of the City in Human Development	5
Third World Urban Trends	10
Chapter II -- Urban Energy Use by Sector	16
A. Industrial Energy Use	16
Non-Commercial Energy Use in Industry	24
Small-Scale Industries and Energy Use	26
The Advanced Developing and Balanced Growth Countries	28
Primary Exporters and Agriculturally-Oriented Economies	31
Developing Country Responses to the Energy Crisis in Industry	35
B. Informal Sector	37
C. Large Commercial Enterprises and Government Services	41
D. Household Energy Use	45
1. Introduction	45
2. Cooking and Water Heating	47
3. Lighting	50
4. Space Heating and Household Appliances	50
E. Construction	52
F. Transportation	62
G. Rural-Urban Linkages	74
1. Introduction	74
2. Urban Forestry and Fuelwood Production	77

Chapter III -- Energy Problems and Outside Aid 90

A. The Data Gap Problem 90

B. Comprehensive Strategies 91

1. Introduction 91

2. Excessive Urbanization and Energy Strategies 94

3. Resource Conserving Urban Design 95

C. Aid Activities by Sources of energy 103

1. Oil, Coal, and Gas 103

2. Hydroelectricity 104

3. Nuclear 105

4. Solar Energy 106

D. Sector Level Urban Energy Strategies 108

1. Energy for Industry 108

2. The Informal Sector 122

3. Energy for Government and Commercial 125

4. Households 131

5. Construction 133

6. Energy for Urban Transportation 136

7. Urban Forestry and Fuelwood 142

Chapter IV -- Aid to Third World Energy 144

A. Suggested Methodology 144

1. Get the Facts 144

2. Make the Facts Available to Policymakers 147

3. Improve Local Capabilities in the Energy Field 148

4. Help to Finance Urban Energy Activities 149

Acknowledgements

In preparing this paper we consulted frequently with staff of AID, IDCA, State, DOE, and the World Bank all of whom were generous with their time and information. We consulted extensively with staff at the State University of New York at Stony Brook including Robert Nathans, Director of the Institute for Energy Research, Philip Palmedo, Gordon McGranahan, and James Bever, who since working on the subject in its early stages at ODC had transferred to IER. We consulted with and commissioned papers by Dennis Bakke, Richard Shackson, Isabelle Wade, and Donald Watson. Major portions of Chapter III and the section of Chapter II on Urban Forestry were adapted from papers submitted by Mr. Bakke, Mr. Shackson, and Ms. Wade. To all of these people we are grateful. This paper was made possible by a grant from AID.

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Introduction

A key issue confronting AID is whether to get involved in helping resolve urban energy problems. There are powerful reasons for deciding this question in the negative. AID was given a new mandate by the Congress in 1973, a mandate to focus on the poorest people especially on rural people with particular concern for their basic needs for food, health, and education. On the whole, Congressional support for AID seems to be less fragile and fickle since that new mandate than in the years preceding it. Moreover, at least some AID practitioners report that it is easier to manage an AID program with only four or five fields of activity (health, agriculture, education, rural energy, and family planning) than one that attempts to provide aid in any field in which the United States has expertise to offer. If AID gets heavily involved in urban energy, it will be a major departure from the 1973 mandate and it will represent one more complicated field of activity in which AID must acquire a degree of expertise. Moreover, there is the danger that whatever funds are devoted to urban energy will reduce funds available for agriculture, health, etc. since Congress may be unwilling to increase total funds available for AID.

In contrast, there is also a strong case in favor of undertaking AID activities in the urban energy field. To begin with, the United States has more expertise in urban energy than it does in rural energy. Moreover, some countries may consider urban energy more important than rural energy to their development. The high costs of imported oil may be a heavy burden to the development of many LDCs. Since the lion's share of oil is used in the urban areas, any efforts to save oil or replace it with other sources must emphasize urban energy. Even if AID were to adhere rigorously to a policy of helping poor, rural people to meet their basic needs, it is not clear that the best way of

doing that in the energy field is always to work on rural energy. Energy and energy-intensive materials flow from urban centers to secondary cities, market towns, villages and farms, and vice versa, and at every step in the chain there is extensive substitution between energy coming from urban centralized systems (e.g., kerosene or electricity) and energy from decentralized rural based systems (e.g., wood or charcoal.) For example, in some areas so much wood may be extracted from rural areas for urban use at the cost of great environmental damage to rural areas that the best way to help protect the rural areas from devegetation might be to help cities conserve energy or find substitutes for wood and charcoal. The linkage between urban and rural energy is so close that greater understanding of urban energy may be essential in order to design sound rural energy projects.

Finally, a strong case can be made for working on urban energy from the point of view of U.S. energy security.[1/] Very briefly, the case is that because of the highly international character of oil, the great U.S. dependence on oil imports and the approach of the day when world oil supplies will fall short of world needs for oil, the United States (and the rest of the world) need to undertake efforts to find oil, find plentiful substitutes for oil, and save energy anywhere in the world especially (because they are most neglected) in the oil importing developing countries. Because most Third World opportunities to save oil and to install substitutes for oil exist in urban areas, some of the most promising opportunities to improve U.S. energy security lie in energy work in the urban areas of the Third World. Again, from the national interest viewpoint, strong healthy developing-country economies offer more opportunities for mutual gains from trade. At least over the short-term oil will be indispensable to maintaining the health of these economies.

These arguments for the affirmative seem to be even stronger than those for the negative, but some of the negative arguments are nonetheless troublesome. There may be factors that, upon closer examination, can mitigate these problems. For example, the argument that the Congress prefers AID to concentrate in four fields of activity may be weakening as Congress demonstrates its keen desire to have AID get into energy including not only small-scale renewable energy but conventional energy as well. It is increasingly doubful that a strong energy program including energy for urban areas would decrease Congressional support for AID. Another serious obstacle to increasing expenditures on energy is the danger that such increases will be offset by decreases elsewhere in the AID program. But it is not clear that the U.S. Government could not be persuaded to increase the total size of the AID program by the amount of an expanded energy program--particularly if a strong argument were made that this is a cost effective way of increasing U.S. energy security. It may be that the chances for increasing AID's "ceiling" will be improved if a new category for energy (or energy and environment) is established in a substantial amount (say $250-$500 million). A package of $50-$100 million might be small enough to tempt Congress to direct that it be absorbed within the total. To be sure, the likelihood of a major increase in this tight budget year is not good but circumstances may change. President Carter is on record as wanting to increase U.S. aid to .5 per cent of our GNP whenever it becomes practical.

Our conclusion is that AID should offer to those countries that request it assistance in the area of urban energy. This does not mean we believe urban energy is more important than rural. Indeed, if U.S. advice were asked on whether to put rural or urban energy first, the best answer would probably be rural in most of the Fourth World and in some of the advanced developing countries. Rather,

our conclusion is that we should not rule aid to urban energy generally ineligible because it probably makes sense in a number of cases. Even where rural energy is clearly a higher priority than urban it may still make sense for a country to do certain kinds of work on urban energy.

The rest of this paper will not address further the question whether any given aid agency should help the Third World with urban energy. That is a question for AID and other aid agencies to decide for themselves and the proper answer will depend on the particular developing country and aid agency involved. Instead, this paper will discuss the key Third World problems and needs in the field of urban energy and what those aid agencies that are so disposed can do to help Third World countries with their energy problems in urban areas.

Chapter I - The Role of The City in Human Development

From earliest times and in all parts of the world, cities have been so closely associated with the processes of social, economic, and political advancement that it is difficult for most casual students of history to think in terms of other than urban forms of development. Periclean Athens, Republican Rome, and Elizabethan London are among those cities whose names are inextricably linked in the minds of most of us with the processes whereby the vigorous young societies they epitomized achieved national identity, evolved effective forms of social and political organization, and extended commerce aggressively outwards. Indeed, human history itself, is generally treated by historians as commencing simultaneously with the evolution--at different times and in different parts of the world--of settlements of a size, order of complexity, and economic function radically different from the rural villages that unchangingly characterized the preceding millenia of post-Neolithic, pre-literate civilization.

Given this predisposition to think of development, progress, and even history itself as closely linked to, if not synonymous with the kinds of things that happen in cities, it is important to remember that, from Mohenjo-Daro to Chicago, settlements have been generated from and sustained by the ability of their agricultural surroundings to produce more food than farmers require for their own needs. Historically, it has been the unique ability of cities not to produce wealth and organization ex nihilo, but to utilize the wealth represented by agricultural surpluses in such a way that additional wealth is created and society as a whole--or important elements of it--benefits.

Essentially, cities appear to have developed in reponse to improvements in agricultural productivity that enabled large numbers of what formerly were farm laborers to survive "away from the land", pursuing commercial and manufacturing

activities for which they earned profits or wages. This previously unattainable concentration of human numbers and continuously increasing economic efficiencies resulting from specialization, scale, and concentration created exponentially more complex patterns of social relations and, thus, necessitated correspondingly ever more institutionalized and pervasive forms of political organization and control.

Historically, then, cities may be said to have originated from and greatly to have magnified the benefits of improvements in agricultural productivity. Underlying both the revolution in the productivity of the soil and the quantum leap in development represented by urbanization were fundamental improvements in human access to and use of energy. There is good reason to suppose that a relatively short time before the emergence of the first cities, farmers learned to increase the size of their harvests improving the use of basic forms of solar, animal, and mechanical energy. In the broadest sense, the development by late-Neolithic farms of what were early versions of hybrid plant strains represented a major harnessing of direct solar energy in the form of nutrition. The use of draft animals and improvements in the utilization of the energy they embodied by means of increasingly sophisticated yoke designs greatly extended the potential area of cultivation and its productivity as did the mechanical multiplication of human and animal energy accomplished by the plow. The development of metal plowshares and other farm implements in later centuries likewise served to increase the energy which farmers could apply to their tasks. Increasingly complex and cooperatively designed and maintained irrigation systems in effect harnessed the gravitational energy in flowing water to extend both the area and productivity of land under cultivation. Mechanical waterpower devices were discovered as well to be an effective source of energy for directing irrigation and to power mills for processing grain into flour.

If the earliest of these energy breakthroughs made possible the first cities, the city itself may properly be seen as a device for conserving and multiplying the effects of human and other energy. Most obviously, the "invention" of the city acted to reduce the time and energy necessary for all kinds of transportation internally and externally. In this way, the numbers and forms of possible social and commercial interactions per unit of energy, were radically increased. The first large towns evolved from crossroads of transportation in agricultural regions.

The energy-based revolution in productivity created not only agricultural surpluses and the problem of what to do with them, but also the solution to the problem in the form of surplus (formerly farm) labor centralized in embryonic cities. The role of the merchant was established to find ways of collecting and storing the surplus as rapidly and effectively as possible and distributing it efficiently for the benefit of the ruling class, their servants, and their constituents. In order to motivate the farmers, the production of manufactured goods with which to recompense farmers and others, was accomplished by methods which implicity relied on the principle of specialization of labor, esentially a device to maximize the energy efficiency of human productive efforts.

In what are now the indusrialized nations of Europe and North America, the Industrial Revolution--and the urbanization that accompanied it--were made possible by a gradual process of agricultural development essentially representing, like those of the pre-urban era, advances in man's ability to utilize the solar energy converted by plants into nutrition. Among the major improvements in the 17th, 18th, and 19th centuries were the introduction from the New World of important feed and food crops incuding corn, beans, and potatoes; the widespread use of rotational farming and enclosed crop and pasture lands; the use of fertilizers; selective breeding of livestock; and, parallel to technological progress in industry,

the development and application of labor-saving, yield increasing farm machinery. The resulting dramatic enhancements of productivity both per acre and per farm laborer made available to industry a steady stream of formerly agricultural labor.

At least from an energy standpoint, the Industrial Revolution consisted of two relatively distinct phases corresponding to the fuels and forms of energy in use in each. Coal and coal-generated steam characterized the earlier phase, oil and electricity the later. During the entire period, it is clear that sufficient energy was readily available to power both industrial development and the domestic and other needs of expanding populations. Likewise, the growth of population in general and the labor force in particular seriously exceeded the capacity of the economy as a whole to employ it.

Just as revolutions in the use of energy produced and characterized the earliest human settlements of a recognizable urban size, so in the late 19th and 20th centuries, new energy breakthroughs in agricultural techniques and in the use of fossil fuels for industry and transportation brought about the creation of the modern metropolis. It has been estimated that in 1800 only 3 per cent of the world's population lived in settlements of more than 5,000 inhabitants and only 45 cities, worldwide, had populations of 100,000 or more. By 1979, the world's population had grown about 4.8 times larger to a total of 4,320 million, 1,685 million of whom are city-dwellers.[1/]

Until very recently, then, the entwined histories of energy and urbanization in the West have been marked, on the whole, by extraordinarily successful complementarity and interaction. Advances in agricultural productivity have both set the stage for and complemented urban-centered and energy intensive development of output levels in manufacturing, commerce, and the provision of services. Though temporarily staggering setbacks have been encountered along the way, like economic depressions, it is certainly correct to say that the overall result of these processes has been increasingly high standards of living for most classes of society.

The history of what is sometimes accurately, sometimes wishfully called the developing world presents, with few exceptions, a strikingly different picture. In these nations, urbanization often has represented not so much a positive, healthy response to the stimuli of increased farm output and factory potential as a bitter accomodation of fierce population pressures upon increasingly inadequate farm lands. Rather than supporting and complementing urban industrial development through the creation of ever larger surpluses, agriculture in many Third World countries increasingly has been unable to keep apace of the needs of burgeoning rural as well as urban populations and so has burdened the cities with vast inflows of people--talented and hardworking people to be sure--but too often destined to become rural refugees rather than industrial laborers. Whereas 19th century industry in Europe and North America displaced some workers through mechanization of tasks, at that period in history, industry was sufficiently labor-intensive and economic growth was sufficiently robust in the long run easily to absorb new entrants to the labor force. This has generally not been the case in Third World countries for several reasons. First, urban population growth is several times more rapid than in the developed countries now or at any time in the past. Second, since industrial development in the Third World began at least a century and a half after that of the developed countries, the largely imported industrial technology now in use in less developed countries employs considerably less labor than did the earlier technology employed in the early stages of Western industrial development. Third, and crucial from the point of view of our study, Third World nations are beginning to industrialize at a period of world history in which the millenium long trend towards ever more abundant energy has been, at least temporarily, reversed.

Third World Urban Trends

The aggregate statistics associated with urbanization in the Third World are often of an order of magnitude that tends to paralyze the mind's capacity for constructive analysis and response. In the third quarter of this century, Third World cities added more than 400 million people to their populations; in the final quarter, this very rapid urban growth is expected to triple, swelling developing country cities by an additional 1.2 billion, nearly three quarters of the total growth expected in the developing world.[2/] Current urban growth rates in the Third World, ranging on a regional basis from 3 to 6 per cent per year and in the larger cities from 5 to 10 per cent and above, are and will remain radically higher than those in the industrialized countries.[3/] A 5 per cent yearly growth rate in a city means a doubling of population in 14 years; an 8 per cent rate means that the size of the city is doubled in about 9 years and quadrupled in 18. Whereas among Third World cities in 1950, only Buenos Aires had a population of 5 million, the World Bank estimates that by the end of the century there will probably be 40 cities of that size or larger in developing countries; of these, 18 will have populations of at least 10 million and Mexico City is projected to contain more than 30 million inhabitants in what is already one of the most overcrowded and unhealthy environments on earth.[4/]

Basing their projections on less conservative assumptions than those of the World Bank and less conventional definitions of metropolitan area, some scholars have forecast the development in the Third World of sprawling urban conurbations of a size to dwarf the largest present cities. These "megalopoli" would extend between and around currently separated urban centers such as Cairo and Alexandria, Calcutta, and Kharagpur would contain upwards of 50 million inhabitants.[5/]

In order to begin to comprehend the implications of such awesome growth, it is necessary to consider present Third World urban conditions and the problems they already pose for planners.

At first glance, it would appear that the principle most accurately characterizing Third World cities is that of contrast and contradiction. First of all, the range of overall organizational and technological sophistication of economic activities in these cities is astonishingly broad. Nearly all of the larger urban centers benefit from some form of advanced industry, for example, textiles and electronics in Singapore, automobile assembly in Sao Paulo, and steel-making in New Delhi. At the same time, half or more of urban employment is often provided by small-scale and informal services and manufacturing enterprises based on extremely rudimentary technology.

Second, the diversity of living styles and habitations is at least as great as the range of sophistication of economic activities. Housing runs the gamut from jerry-built tar paper and tin structures to traditional rural mud and thatch dwellings to the most modern concrete and glass houses and apartment buildings. People's means of performing the same day-to-day activities present correspondingly striking contrasts. In the traffic of Cairo, Mercedes Benz limousines contend loudly with bicycles for the right of way, diesel trucks with oxcarts. In Karachi, two families prepare dinner, one on a twig stove set on a dirt floor, the other on an electric range in a brightly-lit kitchen.

Third and most important, appalling disparities of income underlie and prevent the integration of all the other contrasting, contradictory, and potentially warring elements of Third World urban life. In Third World cities, as nowhere else on earth, the jarring paradox of rising expectations and increasing levels of absolute and relative poverty is plainly visible. Though average income in Third World cities is uniformly higher than in the countryside, it

is probably also true that, for those on the proportionally very densely populated bottom end of the income scale--the hundreds of millions of city-dwellers whom the World Bank describes as living in conditions of "absolute poverty"--life is more difficult to sustain in the urban environment than it would be in the country. Whereas in rural setting, except in extraordinary times of famine or other disaster, a destitute person can always rely on the supportive network of his or her extended family, tribe or clan, in the city, such family and societal bonds are often far weaker or completely eroded. Similarly, whereas in the countryside a resourceful person can usually always count on his natural surroundings to provide minimal sustaining resources such as twigs for cooking, water to cook with and bathe in, and forage of one kind or another for food, in the city, life at the margin can be far harsher.

In Bombay, the resident of an air-conditioned luxurious apartment can look out of his tinted picture window on the twenty-fifth floor at dusk and savor the remotely lovely sight of refuse fires being lit one by one by sidewalk-dwellers in the gathering obscurity below. The fact that urbanization has on the whole, seemed to lead to raised incomes is probably of little consolation to those who are part of the picturesque scene below.

It is one of the more poignant ironies of Third World cities that, to an immeasurable but certainly very large extent, the so-called revolution of rising expectations is itself to blame for some of the worst urban problems. Drawn to the cities by a desire for better employment and other conditions as well as forcibly expelled, in effect, from the countryside by worsening conditions there, rural migrants have been and will continue to be the major source of additions to burgeoning urban populations.

There continues to be disagreement among scholars as to what happens to these migrants upon their arrival. Traditionally, there has been a tendency

to think of them as collecting among the poorest of the poor in the squatter-villages and shantytowns--the favelas of Brazil, the bidonvilles of West Africa, the bustees of India, and the callampos and barrios of the Philippines--that form the fringes of so many Third World cities. Similarly, scholars at one time assumed that, if not remaining indefinitely unemployed, the heads of migrant households entered the labor market by way of the relatively low-paid informal sectors of urban economies. More recent evidence suggests that potential migrants, often seem to be the most enterprising and ambitious of village dwellers, and base their decision to move on hard, accurate information as to employment and other opportunities or even in response to the offer of a job arranged by friend or relative living in the city.[6/] According to this view, recent migrants may be at least as likely to find work in industry or elsewhere in the formal sector as settled city dwellers.

Whatever the precise nature and destination of rural to urban migrants, they have put an enormous demographic strain on the already overburdened ability of Third World cities to provide their citizens with food, shelter, education, water, sewerage, and employment. The World Bank estimates that slightly less than one third of city dwellers in developing countries, 250 million people, lack access to these basic necessities of life. Their numbers are growing by 15 to 18 million per year, according to the Bank, and, unless present trends are altered, will reach 600 million by the year 2000.[7/]

These conditions are at their worst in the shantytowns and squatter villages that cluster along the fringes of Third World cities. These settlements--usually illegal and nearly always unserviced--are generally growing twice or three times as fast as the urban population as a whole.[8/] One-third of the population of Mexico City is contained in its slum areas; "half of the people of Ankara live in its 'gecekondu'" ("buildings of the night").

Usually the response of urban decision-makers to the festering problem of the shantytowns has been either to ignore them, in the hope that they will go away or at least not create political problems, or to try to erase them, as visible symptoms of the failure of their policies. Often, shantytown neighborhoods have been forcibly evacuated and the homes in them bulldozed, on grounds either that the residents lacked legal title to the land or that their houses were structurally "substandard." Generally, in such cases, no provision is made for the newly homeless, who have in a sense, been demoted from the ranks of the urban poor to the status of urban refugees.

Where shantytowns have been suffered to exist without benefit of basic amenities like water and sanitary facilities, conditions, not surprisingly, in them have generally deteriorated or shown no tendency to improve. However great the efforts made to segregate them from "normal" urban life, they increasingly threaten hopes for rational, planned, and equable development.

Encouragingly, there are more than a few cases in which city planners, with the help of international agencies have actively sought to come to grips with problems of shantytown poverty. In Nairobi, a project involving CARE, the World Bank and Peace Corps Volunteers with local authorities is building free and affordable housing with access to basic services for the poor. In Calcutta, The Metropolitan Development Authority has, for a cost of $21 per head, cut the city's cholera death rate by 95% through a program of basic sanitary improvements and the installation of tube-wells for drinking water. In Dakar, a comprehensive "sites and services" program financed by the World Bank has accomplished a great deal through self-built housing and extention of services since it was initiated in the late 1960s.[9/] In some cities, the shantytown dwellers themselves have had the resources and initiatives to make significant improvements in their neighborhoods and organize themselves politically to obtain minimal services from the government.[10/]

Nonetheless, there can be no doubt that in most cities the fundamental problems of urban poverty are becoming every year more devastating in their impact on human lives and less tractable in terms of the quantities of resources that would be necessary to palliate their worst effects, let alone substantially alter the trends underlying these effects.

Given the currently low levels of international concern for and aid to Third World cities relative to the magnitude of the urban problem, what are their prospects for the next two decades? While the nature of the basic parameters is clear, their quantities, especially in the longer run, will be determined by many interdependent contigencies.

Population growth, both rural and urban, and other demographic trends, obviously, are crucial. Since urban growth is compounded of rural migration as well as natural additions to urban stock, there might be some possibility of moderating the growth of certain Third World cities as early as the turn of the century by vigorous rural development and other countermigration programs. Beyond that, it must be acknowledged that there is little or no prospect of reducing the size of the projected 20-year 1.2 billion increment in total Third World urbän numbers. After all, a good deal of the future is already with us: every adult member of the millenial population has already been born.

The other principle factor influencing urban prospects is, of course, resources. One of most important of these is energy which is the topic of this paper.

Chapter II - Urban Energy Use by Sector

This chapter will analyze primarily intra-urban energy relationships by focussing on individual end-use sectors. Great variation exists in the levels and kinds of urban centers in the developing world, and these towns and cities likewise use widely different amounts and kinds of energy in individual sectors. There are also big differences in the level of sophistication of technology and factor proportions in individual economic enterprises, and in the importance of individual commercial fuels in metropolitan life.

The following sectors will be examined for their energy needs and current energy supply and use patterns: modern large-scale industry together with small-scale industry; the informal sector; large commercial enterprises; government services (especially utilities); household energy use; construction; transportation (intra- and inter-urban) and urban fringe food and woodfuel production and use of waste. A final section will focus on the kinds of energy flows between urban and rural areas and the economic and social effects of these flows. Though the descriptions will attempt to generalize for all developing countries, individual examples will be given to illustrate the diversity of urban energy use among developing countries.

A. Industrial Energy Use

Since the Industrial Revolution in Europe, development strategies that emphasize a rapid expansion of material growth--and modernization in general--have focused on industrialization as the primary engine of that growth. In addition, as the discussion in Chapter I indicated, there is a close relationship between the rise of manufacturing industries and social services and the process of urbanization.

Extractive industries and agricultural processing industries, because of their site-specific nature are not often near large cities.

By constrast, industry is attracted to urban areas for a number of reasons. These include the availability of skilled and unskilled labor, the presence of a large market for its goods and a greater chance of finding needed support services, including energy, rapid communications, finance, transport, and professional services. This is particularly important in developing countries where infrastructural development and an educated labor force have tended to be lacking in rural areas.

Virtually every developing country has some sort of industrial development. However, the differences between developing countries are often very great; there are differences in the composition of their industrial base, the extent of industrialization and its role in the nation's development strategy (as reflected in the degree of capital and energy intensity on the one hand and labor intensity, on the other). A great range exists in the share of labor force employed in industry in the Third World, ranging from as much as 57 per cent in the case of Hong Kong to only 2 per cent in Nepal, (1977).[1/]

Industrialization in the Third World has tended to occur for different reasons than was the case in most of the developed countries. Though many of the latter certainly benefited from foreign investment, much industrialization was due to capital savings generated from other sectors like agriculture or trade. Indusrialization in many developing countries has been a forced draft process, made possible by large foreign investments or official borrowings and often in economies with weak agricultural bases, undeveloped infrastructural systems (e.g., roads, communications, social services), and relatively adverse international grading conditions (especially in commodities.) In many countries, industries have either been for exports or for small domestic markets. Industrialization, as a consequence, has been likened to "Belgium inside India" in terms of the lack of integration between small developed urban centers and large stagnant rural sectors.

In this section, we will examine the impact of these factors on the development of industry in the Third World and then describe industrial energy use by different country groups. These county groupings, while not mutually exclusive are offered for the sake of convenience of analysis since it would be impossible in a paper such as this to do a country-by-country examination. On the other hand, to generalize for all developing countries could be very misleading. The country groupings are: the advanced developing countries, balanced growth economies, primary exporters and agriculturally-oriented economies.[2/] (See Table 1.) The countries within each group are not homogeneous, but they tend to share a number of common attributes, the most important of which is that industry has about the same weight in the gross domestic product (GDP) within each category. Because of this similarity, the country discussions of industrial energy use will group the first two kinds of countries under one heading as well as the last two under a second heading. The OPEC countries are not explicitly considered here, but for some of them, e.g., Indonesia, Nigeria, and Venezuela, the discussion is applicable.

Until the energy crisis of 1973-4, direct industrial energy planning in developing countries was largely confined to large-scale electricity generation and distribution and petroleum refining. Of course, development plans indirectly had energy effects. To achieve certain factor allocation policies, for example, the encouragement of labor intensive industries, smaller commercial energy inputs might be required for producing a particular good than would have been the case with a more capital-intensive technology. With the end of the era of cheap energy, however, all nations have had to reassess--or consider for the first time--the explicit relationship of energy to industry. This is particularly the case for those developing countries that are either in a stage of heavy industrialization or attempting to begin the process. For many other developing countries with minimal industrial sectors--but ones that rely largely on imported oil--soaring energy costs threaten their plans

Table 1

Country Categories

I. Advanced Developing

Argentina
Brazil
Chile
Hong Kong
Mexico
Republic of Korea
Singapore
Taiwan
Uraguay
Yugoslavia

II. Balanced Growth Economies

Colombia
Greece
Egypt
India
Malaysia
Pakistan
Panama
Peru
Philippines
Syria
Tunisia

III. Primary Exporters

Angola
Bolivia
Botswana
Brunei
Congo
Costa Rica
Dominican Republic
Gamiba
Guatemala
Guinea
Guyana
Jamaica
Liberia
Mauritania
Morocco
Oman
Senegal
Sierra Leone
Sri Lanka
Thailand
Togo
Trinidad and Tobago
Zaire
Zambia

IV. Agriculturally-Oriented Economies

Afghanistan
Bangladesh
Benin
Burma
Burundi
Cameroon
Central African Empire
Chad
Comoros
Cyprus
El Salvador
Eq. Guinea
Ethiopia
Fiji
Ghana
Haiti
Jordan
Kenya
Lebanon
Lesotho
Madagasgar
Malawi
Mali
Mauritius
Mozambique
Nepal
Nicagagua
Niger
Papua New Guinea
Paraguay
Rwanda
Somalia
Sudan
Surinam
Swaziland
Tanzania
Uganda
Upper Volta
Yemen Arab Republic

Source: Adapted from Gordian Assoc., Inc., Energy Supply and Demand Balances and Financing Requirements in Non-OPEC Developing Nations, preapred for U.S. DOE, February 1979.

for building a modern economy and escaping poverty. Even in the case of countries that turned to wood or charcoal for some industries, the growing pressure on the supply of these fuels may force them back onto greater dependence upon imported oil.

In spite of these problems, the developing countries have made progress. Exports of manufactures to the developed countries from the Third World, in general, more than doubled in value from 1972 to 1976, despite the energy crisis and the recession in the North during this period. Nevertheless, exports of manufactures from developing countries still comprised only about 10 per cent of all exports of manufactures to developed countries.

In light of this, the Declaration and Plan of Action passed by the UNIDO Second General Conference and endorsed by the U.N. General Assembly has called for an expansion of Third World industrial production to comprise as much as 25 per cent of world industrial production by the year 2000. If such an ambitious goal is to be reached, it will clearly entail a great expansion of commercial energy consumption in developing countries.

If industrial production is still modest in the Third World, still it seems to have been accompanied by a marked rise in energy consumption. This is especially so for the more advanced developing countries and some balanced growth nations. As Table 2 demonstrates, of some 96 oil-importing developing countries, only 10--all of them rapidly industrializing nations from these two groups--comprise half of the Third World's energy consumption and well over half of its liquid fuels (virtually all oil) consumption. Although six of the countries produce some oil, only 2 in these groups, (Argentina and Colombia) are close to self-sufficiency. Nine of these countries together imported at least $11.37 billion worth of oil at mid-1979 prices, an amount equal to 38 per cent of their 1978 foreign exchange holdings. With skyrocketing oil prices likely to continue, a very heavy burden

Table 2

Oil-Importing Developing Market Countries:

The Ten Most Intensive Energy Consumers (1976)

(consumption in thousands of metric tons of coal equivalent)

Countries or Territories	Aggregate Commercial Energy Consumption	Population (millions)	Proportion GDP from Industry (%) 1976	Per Capita Consumption (kilograms)	Liquid Fuel Consumption
All Developing Market Countries[a]	837,465	1,987.9	28.5%[d]	421	518,317
Oil Exporting Developing Market Countries or Territories (25)	298,654	431.8	45.0%	692	189,072
Oil Importing Developing Market Countries or Territories (96)	538,811	1,557.9	22.0%	346	329,245
The Ten Most Intensive:[b]					
1. Singapore	5,153	2.3	35.0	2,262	5,148
2. Argentina	46,404	25.7	45.0	1,804	32,626
3. Taiwan	27,547	16.3	46.0	1,690	20,000[c]
4. Hong Kong	5,754	4.5	31.0	1,279	5,735
5. South Korea	36,583	36.0	35.0	1,016	19,350
6. Chile	10,323	10.5	29.0	987	6,595
7. Brazil	79,840	110.0	37.0	726	62,216
8. Turkey	29,830	41.2	25.0	724	21,140
9. Colombia	16,657	24.2	29.0	688	9,422
10. Peru	10,336	15.8	31.0	654	8,747
Total of the Ten	268,427	286.5	34.3 (average)	937	190,979
Total of 86 Others	270,384	1,271.4	20.0 (average)	213	138,266
Share of the Ten in the 96 (%)	49.8	18.4	---	---	58.0

[a] United Nations classification, subtracting Puerto Rico, U.S. Virgin Islands, Panama Canal Zone, Cuba, Netherlands Antilles, New Caledonis, Guam, and French Polynesia; and adding Taiwan.

[c] Rough approximation only.

[d] Data available for only 80 developing market economies as to breakdown of GDP. Within this group data available on 16 oil exporting developing countries (OPEC and non-OPEC) and 64 oil-importing developing countries. From, World Bank Group, World Development Report, 1979. Annex Table 3.

Source: Derived from, Lincoln Gordon,"International Energy Arrangements and the Developing Countries", July, 1979 discussion paper of the Ford Energy/LDC Group, (Resources for the Future, 1979) and U.N. data.

falls on these governments either to find more oil, conserve their present use and to find substitutes for oil if they are to sustain this level of urban and industrial energy demand.

Energy use varies widely in the production of industrial goods. Even among heavy goods this is the case. Under U.S. production conditions, it takes about 1,650 times as much energy to produce a ton of aluminum as it does a ton of coal and over 5 times as much energy to produce a ton of steel as it does to produce a ton of cement, (see Table 3.) Moreover, developing countries vary greatly in their profile of industries, due partly to wide differences in the size of domestic markets, resources, work force, and capital availability. Thus, any detailed analysis of the industries demand effects on energy consumption in a developing country would need to be done on a case by case basis. Having said that, however, some generalizations can still be drawn for all countries.

One particular class of goods, basic materials, is important both for building a nation's material infrastructure, roads, bridges, buildings, and as intermediate goods for a variety of manufactured products. Hence, they are accorded a high priority in most industrialization plans. Most basic materials goods also happen to be very energy-intensive in their production. Basic materials industries include: iron and steel, other primary metals, including aluminum, copper, lead, zinc and tin, fertilizer production (as measured by its content of nitrogen, potassium and phosphorus), other heavy chemicals, hydraulic cement, pulp, paper and paper board, refined petroleum products, magnesium and structural clay products (tiles and bricks). The production of these goods has been found to be "highly correlated with energy and electricity use at all levels of development."[3/]

The relative importance of energy-intensive materials industries to total industrial energy demand in developing countries varies considerably with the level of

Table 3 Energy consumption in basic-materials processing during 1968; reproduced from A. B. Makhijani and A. J. Lichtenberg, "Energy and Well-Being," Environment 14, 10-18, June 1972.

Material	Energy for unit production, kwh_t/t	Machinery depreciation[a] kwh_t/t	Transportation[b] kwh_t/t	Total, kwh_t/t	1968 material consumption t	Total energy kwh_t	Percentage of total 1968 energy consumption
steel (rolled)	11,700	700	200	12,600	90×10^6 (excluding alloys)	1.13×10^{12}	6.20
aluminum (rolled)	66,000	1,000	200	67,200	4.07×10^6	2.74×10^{11}	1.49
copper (rolled or hard drawn)	20,000	800	200	21,000	2×10^6	4.2×10^{10}	0.23
silicone, metal, and high-grade steel alloys	58,000	1,000	200	59,200	2×10^6	1.19×10^{11}	0.65
zinc	13,800	700	200	14,700	1.5×10^6	2.2×10^{10}	0.12
lead	12,000	700	200	12,900	0.467×10^6	6.05×10^9	0.04
miscellaneous electrically processed metal	50,000	1,000	200	51,200	2×10^6	1.02×10^{10}	0.06
titanium (rolled)	140,000	1,000	200	141,200	16×10^3	2.24×10^9	0.01
cement	2,200	50	50	2,300	74×10^6	1.7×10^{11}	0.93
sand and gravel	18	1	2 (short distance hauling)	21	918×10^6	1.83×10^{10}	0.10
inorganic chemicals	2,400	100	200	2,700	67×10^6	1.8×10^{11}	0.98
glass (plate finished)	6,700	300	200	7,200	10^7	7.2×10^{10}	0.39
plastics	2,400	300	200	2,900	6×10^6	1.74×10^{10}	0.10
paper	5,900	300	200	6,400	50.7×10^6	3.24×10^{11}	1.77
lumber	1.47 per board foot	0.02 per board foot	0.02 per board foot	1.51 per board foot	3.75×10^{10} board feet	5.66×10^{10}	0.31
coal	40	2	---	42	556.7×10^6	3.3×10^{10}	0.20

[a] These are approximate numbers derived as follows: the steel calculations refer to one ton of installed equipment (excluding buildings) per annual ton of steel production. Depreciation is calculated on a 30-year, straight-line basis. For non-electrically processed metals, the depreciation is taken to be equal to that for steel. Production facilities involving predominantly electrical equipment are amortized over 20 years and therefore the depreciation/t is 1.5 times that for steel. For non-metals, the depreciation/t allocation is about 5% of the energy required for producing one ton of product.

[b] These figures are based on the sum of the average railroad shipping distance (286 miles, i.e., the average distance between major stops) plus 200 miles truck freight (this is an approximate value, based on the fact that truck freight is in general comparable to train freight).

Note: kwh_t/t refers to a kilowatt-hour of thermal energy-equivalent per ton of goods produced.

development and the kind of industry in each country. Where a country has a relatively less developed industrial sector or is otherwise less energy-intensive (encouraging more labor intensive industries, for example), the impact of a few energy-intensive industries can be large. This is illustrated in the sample of countries discussed in the advanced developing country section in Table 2, p. 19a all of which are relatively more developed Third World countries. Nevertheless, in four out of the seven, just a few industries dominate industrial energy demand. Moreover, a very large proportion of the energy used in these industries is in the form of oil products, (with the exception of India). For those countries that import oil, a modest expansion in industry may entail a heavy drain on foreign exchange holdings over and above their capital requirements and other non-energy import demands.

Though industries like iron, steel, and cement are inherently energy intensive, some reduction in their use of energy is possible. In the wake of the energy crisis --and even well before it for certain industries--some energy-intensive materials production technologies became more energy conservative (some of these will be discussed in Chapter III). Hence, to the extent that developing countries have industrialized very recently, they may have obtained more energy saving technology. Such was certainly the case in Japan and Germany, for instance, whose economies were reconstructed following World War II with more efficient iron and steel technology. Nevertheless, further industrial energy savings have barely been explored yet, despite the heavy cost of energy in these industries.

Government pricing and taxing policies can have a very strong effect on how industry uses energy and, to a significant extent, the kinds that it uses. U.S. government policies that controlled the price of natural gas, for instance, or kept low taxes on gasoline, have helped to shape industrial and consumer product technology considerably differently than in Europe. In many cases this has resulted

in higher energy use for similar activities.[4/] This has also been the case in the developing countries. India and Korea can serve as cases in point (by no means the only ones). Both of these nations possess sizeable coal resources (though India's resources are considerably larger than Korea's.) In 1955, most of India's industry relied on coal and it supplied, in fact, about 78 per cent of India's total commercial energy consumption. Twenty years later, coal was still dominant in industry supplying about 68 per cent of final energy consumption in that sector compared to about 6 per cent for oil. The reason for this low petroleum energy use lay in India's chronically tight balance-of-payments position. Since the country imported most of its oil, and faced a relatively modest export market for its goods, strict controls were placed on oil use and emphasis was given to more plentiful resources.[5/] In contrast, from 1966 to 1974, Korea was establishing most of its industry and at a time when oil costs were relatively low. Thus, oil was perceived to have a comparative cost advantage for Korea's set of industries. In 1966, Korea's industry obtained 33 per cent of its energy in the form of coal and half in the form of oil. In the space of eight years, coal dropped to only 4.6 per cent of industrial energy use and oil rose to 77 per cent. This translated into a 547 per cent rise in industrial oil use and a 40 per cent drop in coal use. Korea, unfortunately, has no indigenous oil and, hence, the share of oil in imported fuels rose from 7 percent to 16.2 percent of total energy consumption. With the demise of cheap internationally traded oil, this became an enormous financial burden. Not surpringly, Korea's current five-year plan calls for a 65 per cent increase in its use of coal for industry.[6/]

Until recently, many governments, including those in the developed countries, actively promoted industrialization through the manipulation of energy prices, (for example, declining block electricity tariffs for large industrial users). Even in the case of very labor-intensive economies, electricity use in industries

is encouraged in order to upgrade product quality to world standards. More than 62 per cent (1971) of Hong Kong's electricity, for example, went to industrial use.[7/] Likewise, in the face of a tripling of the cost of imported petroleum in 1974, Korea applied taxes on its petroleum products that were quite small for those products applicable to industry but as much as 300 per cent in the case of gasoline. Yet, experts claim that Korean industry offers many opportunities for efficiency improvements and fuel switching possibilities.[8/]

Non-Commercial Energy Use in Industry

Special note must be taken of the important and often unappreciated role of non-commercial energy in Third World industry, especially fuelwood, charcoal, and agricultural wastes as well as some solar energy mainly for crop drying as in coffee beans and copra (from coconuts.) The importance of non-commercial fuels in individual industries varies widely according to the availability of the resource and the local cost of commercial alternatives. Non-commercial energy is used in both developing and developed countries in some industries--indeed it is becoming increasingly popular in some industrialized countries since the oil crisis, especially in those industries like forest products, where the main input is an agricultural commodity. Its principal uses are for on-site generation of process heat and power.

A number of observers have noted that some industries have started switching out of petroleum products into non-commercial fuels like wood and charcoal where the market price is less than for oil products. This is particularly the case in the Sahel. Unfortunately, in most cases the charcoal used has been produced inefficiently resulting in a great wastage of wood and has contributed to deforestation. In such cases, the market price is a poor representation of the true cost to the economy of using these non-commercial fuels.

An accurate assessment of the use of non-commercial energy in industry is not possible at this time owing to the lack of systematic data on these fuels in developing countries. However, it is suggested that its role may be important, especially for a few large industries and many small-scale or artisanal industries. A suggestion of the probable current range of industrial uses of these fuels is given below.

Charcoal is used for pig iron production in Argentina, Brazil, India, Malaysia and also in Australia.[9/] Surinam and Uganda have or are studying the possibility of using charcoal in future mills of their own. Brazil is the largest producer of charcoal pig iron in the world, about 2.25 million tons in 1977. It is a longstanding managed operation requiring the consumption of 23.85 million cubic meters of forest wood converted to about 2.3 million tons of charcoal in 1975. In addition, the by-products are also captured and marketed including methanol used for denaturing ethanol, acetic acid used in the textile industry and tars used in highway construction. The charcoal is used both to reduce the iron ore to pig iron and for heating in the smelting process. (The advantages and disadvantages of producing charcoal are discussed further in Chapter III of this report.) Currently, Brazil uses mostly natural forests but is planning to move towards managed eucalyptus plantations. Malaysia uses mainly wood from old rubber trees. Small amounts of fuelwood are used in Bangladesh in the production of bricks, chemicals, and pharmaceuticals, in the processing of non-metal minerals and in the textile industry. A total of 55,200 tons of firewood was used for industrial purposes in that country in 1969-70.[10/]

Fuelwood and charcoal may be even more widely used in a variety of light industries and, in some cases for the generation of electricity. U.S. AID is involved in a project in the Philippines to generate electricity from fuelwood.[11/] Several sources report that fuelwood is an important fuel in the drying of crops such as cassava, tea and tobacco, baking bread, curing fish, and in the production

of bricks and tiles. Charcoal is reportedly used in some ceramic and cement industries as well. It is used in brewing beer (especially traditional beer), in the firing of pottery kilns and is extensively used by blacksmiths. In some cases where its use was phased out in favor of more convenient oil and gas, it is now making a comeback. This has already occurred in parts of the Ugandan tea industry and on Thailand's railways.[12/]

Bagasse and other agricultural wastes have been extensively used--usually on-site--for energy purposes for a long time. The most well-known uses are in the sugar industry where large amounts of crushed cane fiber fire the boilers used to generate process heat and steam for further sugar purification and crystalization operations. In Senegal, peanut shells are reportedly also now being used to power peanut oil plants.[13/] Cotton seed in the Central African Republic, coconut shells in Jamaica, and oil palm press fiber are all used on-site to fuel boilers, and sawdust, and other residues are used in sawmills for fuel on-site in the Philippines, Thailand, and Zambia.[14/] Undoubtedly, there is much unrecorded industrial use of non-commercial fuel that, in the aggregate, may be important in countries where the alternative may be higher priced imported commercial fuels as replacements.

Small-Scale Industries and Energy Use

Thus far, the bulk of this discussion on industrial energy use has been concerned with medium to large-scale industries. It is difficult to draw a firm line between these industries and a separate sub-sector of small-scale industries particularly in developing countries, but there are some significant differences. The small-scale industries discussed here are all considered to be formal sector enterprises, i.e., they are recognized by local governments, pay taxes, are part of the national accounts and are subject to government regulation. Informal small-scale enterprises are discussed separately.

Small-scale formal sector industries in developing countries usually produce a relatively narrow range of products per factory, tend to be relatively labor intensive in their mode of production and often produce for a local consumer market. A partial exception to this last characteristic are exports of traditional products such as cloth prints, basketry, pottery, and the like.

Energy use in small-scale formal sector industries largely tends to be either electricity or traditional fuels. The use of the latter was described in the previous section. For direct heat, other fuels may also be important, e.g., charcoal for pottery firing or metal fabrication for which commercial fuels could also be used. However, at the level of these industries, traditional fuels still seem to be preferred, perhaps due to the higher capital cost of equipment using commercial energy.

Electricity is a very high priority for most small-scale and crafts industries. The improvement of product quality that is obtained with motor driven equipment allows the entrepreneur to market his goods and services, especially intermediate goods, to large-scale enterprises. It may even permit export markets to become available, especially for light consumer goods. A growing proportion of small businesses, particularly in Southeast Asia, are assembly operations. These businesses import components and use cheap labor, assisted by electric motor driven equipment to assemble products such as radios, TVs., clothing, and wood products, for export or local consumption.

Although there is little direct information on the relative energy intensitivity of small-scale industries or on the efficiency of their energy use, the great degree of price competition and the small size of the businesses suggest that not much energy per unit of output is used and little is wasted. Moreover, the specific energy component of the production process may be relatively fixed. For example, in one study of power looms in India, although the number of workers required to operate

Table 4

Country Group 1) (number of entities in each group	Industry as a Percent of GDP 2) (1977 average for each group	Manufacturing Value Added and Percent Share of Country Group of all LDCS		Percent of Commercial Energy Consumption of Total LDC Energy Consumption (1976)	Percent of Population in Urban Areas (1979) average
		Millions of 1970 U.S. dollars	%		
Advanced Developing Economies (10)	38	54643	47	40	72
Balanced Growth Economies (11)	27	21928	19	30	42
All developing Countries	29	116996	100	100	28

Notes: The number of developing countries included in "all developing countries" varied with the source. For Column 2, the number of countries was 74, for Column 5, the number was 123. For Columns 3 and 4, the number was about 135 (including developing centrally planned economies.) For Column 6, it was 131.

Sources: Column 2, World Bank, World Development Report, 1979, Annex Table 3, "Structure of Production." Columns 3 and 4, World Development Report, 1979, Annex Table 6, Industrialization." Column 5, U.N. World Energy Supplies, 1972-1976, Series J, No. 21. Column 6, Population Reference Bureau, Inc., 1979 World Population Data Sheet.

different models varied considerably the power requirements for each were almost the same.[15/]

While the foregoing may serve as a general discussion of the characteristics of industrial energy use in developing countries, it may be useful to examine these characteristics in the context of specific groups of countries. Third World industrial development varies widely with, for example, some of the advanced and balanced growth countries, actually more closely resembling the Western industrialized world than they do their poorer, less developed brethren.

The Advanced Developing and Balanced Growth Countries

These two groups, together comprising only twenty-one nations, nevertheless, dominate the industrial sector of the developing world. Together, they possess two-thirds of the industry of developing market economies,[16/] and comprise about 70 per cent of its commercial energy consumption.[17/] They are also relatively urbanized (an average of 57 per cent in 1979), though this disguises considerable variation especially between large and small countries (e.g., India is only 21 per cent urban while Singapore is 100 per cent urban.)[18/] Table 4 summarizes some of these characteristics.

While industry seems to have an increasingly large role in the economies of these two groups of countries, it is not clear that energy intensivity is high. Industrial demand within the developed countries made up between 30 and 37 per cent of final commercial energy consumption in the early 1970's.[19/] Comprehensive data for these two group of developing countries on industries' share of total commercial energy consumption is lacking. However, one authority has asserted that industry's share of commercial energy consumption in developing market economies, in general, may be considerably higher than in the developed countries.[20/] In fact, the available data would seem to indicate a wide diversity of industry's share of commercial energy consumption among developing market economies as a group. A recent IEA Workshop

on Energy Data of Developing Countries reported industrial energy consumption in their sample of 16 developing countries ranging from 2.2 per cent of final energy consumption in 1976-7, in the case of Jamaica to 54 per cent in the cases of Mexico and India. For the advanced developing and balanced growth economies, in particular, the results also range widely (see Table 5).

The data in Table 5 reflect the fact that countries with a more developed industrial base, also tend to have a greater energy using infrastructure of services and transportation which along with industry greatly raise the level of total commercial energy consumption, and lessen the share of industry in the total. This seems to be the case for the more advanced countries like Brazil, Mexico, and Argentina. Nevertheless, this does not mean that energy costs are any less for these countries. Brazil and Argentina both face the need to find ever larger and expensive supplies of energy in order to maintain their industrial rates of growth, partly because of these other competing demands for energy. This has significant implications for those industrializing nations that have only a few industries and a relatively undeveloped infrastructure. It is interesting to note that in those advanced developing and balanced growth economies where industry has a relatively small share of final energy demand, industrial use of energy is already dominated by demand from just a few energy-intensive industries, such as iron and steel and chemicals. This suggests the heavy demand that these industries place on a country's energy economy, even in these more advanced developing countries. It also suggests that the route of heavy industrialization followed by these countries is likely to be very difficult either to sustain in these countries or to be replicated in many other developing countries given the rapidly rising costs of the kinds of energy that industry uses, especially oil.

Table 5

Country (Year of Data)	Industrial Energy Demand as a Proportion of Final Energy Consumption (%)	Proportion of Selected Energy-Intensive Industries in Industrial Energy Demand (%)
Mexico (1977)	54	5.4% (iron and steel)
India (1976)	54	39.0% (iron and steel, chemicals and petrochemicals)
Brazil (1976)	36	8.1% (iron and steel)
Argentina (1977)	22	10.4% (iron and steel)
Korea (1977)	12	35.0% (iron and steel, chemicals and petrochemicals)
Egypt (1977)	11	49.0% (iron and steel)
Colombia (1977)	7	39.0% (iron and steel)

Source: IEA, Workshop on Energy Data of Developing Countries, December, 1978, Basic Energy Statistics and Energy Balance of Developing Countries, 1967-1977, Volume II (Paris, OECD: 1979).

Primary Exporters and Agriculturally-Oriented Economies

These two groups of countries encompass the poorer countries--in terms of GNP per capita and output of industrial development--of the Third World. These countries tend to have poorly integrated economies, a lower degree of urbanization than the first two groups and a large portion of the population in the rural subsistence sector. Table 1 shows the group of countries included in this category.

Together these two groups comprise the largest number of developing countries --though not the largest portion of population. They have low GNP's per capita, and often a very limited infrastructure. The primary exporters have a total population of 178.9 millions. The population of the agricultural economies is 368.6 millions. The primary exporters include non-industrial, non-OPEC oil producers like Oman and Angola, primary mineral exporters like Zambia, Bolivia, and Liberia, and agricultural commodity exporters like the Dominican Republic, Ivory Coast, and Thailand.

Nearly all primary exporters send out a large amount of their production mostly to the developed countries. Zambia, for example, exports 95 per cent of its copper, 75 per cent of its lead, and 60 per cent of its zinc (1974).[21/]

Commmercial energy use in industry and transportation in these countries often comprises a very large fraction of such energy for the whole economy. A sample of countries in these two groups and their industrial energy consumption is given in Table 6.

Table 6

Industrial Use As a Percent of Total Use by Type in Primary Exporters and Agricultural Economies[a/]

Country	Petroleum Products	Natural Gas	Coal	Electricity
Jamaica (1977)[c/]	n.a.	n.a.	n.a.	44%
Bangladesh (1973-4)	24%	41%	51%	50%
Kenya (1978)[b/]	21%	n.a.	neg.	53%

Notes: a/ all percentages industrial use out of total consumption of each energy form.

b/ Electricity consumption includes a small amount of industrial power generation in Kenya. Data for Kenya also includes "Commercial" end-use consumption.

c/ Data not available for industry uses of some jinds of energy.

Sources: Jamaica: IEA, Workshop on Energy Data of Development Countries, Volume II, op. cit., "1977 Energy Balance"; Bangladesh: UNDP, Bangladesh Energy Study, prepared by Montreal Engineering Co., Ltd. et al. November 1976. Appendix I, Vol. 1, derived from Annex 2.6.1; Kenya: L. Schipper and O. Mbeche, "Energy Demand and Conservation in Kenya" paper presented at the Energy and Environment Conference in East Africa, Nairobi, May 1979, Table 1.

The oil producing members of these two groups possess only 1.5 per cent of the world's proven reserves of oil. (In fact, all non-OPEC countries, excluding Mexico. possess less than 5 per cent of world proven reserves of oil.) Some of these have had modest additions to reserves, but for the bulk of them, their reserve levels and production capacity have been fairly stagnant recently. Nearly all of them have some refining capacity though most of their output goes out as crude.

The two major areas of primary exporter industrial energy use lie in the extracting (or growing and harvesting) of the commodity and whatever processing takes place, (a third area, movement of the commodity for export is dealt with under transportation.)

Primary exporters of minerals have their largest industrial energy costs in the form of extraction and processing machinery. Most of the machinery for digging and mining uses a great deal of energy, most of it in the form of oil and electricity. This is particularly noticeable in those countries that are relatively undeveloped outside of their primary export industry. For example, in 1975, the Taiba mines of Senegal consumed fully 21 per cent of that country's total electricity production (and 34 per cent of its high voltage industrial power) as well as 30 per cent of the country's consumption of diesel oil.[22/] To the extent that some of these countries are engaging in initial processing of aluminum or iron ore smelting, this also requires a great deal of energy either in the form of hydroelectricity, where available (e.g., Ghana) or coal and oil. Most of the extracting and processing machinery is imported, large in size and fairly complex in technology, and represents a great deal of imported embodied energy (energy used in making the machinery) which is reflected in the rapidly rising prices for such machinery. This appears to be a growing problem for primary exporters--both of minerals and of agricultural commodities--and may be becoming an acute one

for many of them since a number of these commodities, e.g., copper, cocoa, and coffee show large cyclical fluctuations in their international selling prices, adding to these exporters' balance of payments problems (particularly for the larger producers.) One source has calculated, in the case of Kenya, the embodied energy in certain industrial supplies (not including food, machinery, and other capital and transport equipment) for 1974. The ratio of imports to exports of these industrial goods was nearly 3:1 and the total energy represented in these goods appeared to be the equivalent of more than half of Kenya's recorded energy use.[23/]

Agricultural commodity producers also face significant industrial energy costs in machinery for planting and harvesting, commonly on large-scale plantations and managed forests of their crops, in commercial fertilizers and in processing equipment. For some commodities like sugar, considerable processing is necessary before export is possible.

Both national governments and foreign multinational corporations frequently play important roles in the ownership and operation of primary commodity enterprises. Their decisions on the kind of technology to be employed (and the associated embodied and operating energy costs) are part of a critical and often controversial set of development policy issues for many of these countries, including, for example, decisions on the optimum mix of labor and capital equipment in countries where employment generation is a problem.

Because these government and multinational enterprises tend to be large scale, however, they can reduce the proportion of energy-intensive equipment use only at the expense of a loss of efficiency and higher production costs. Given the fluctuating nature of most commodity markets, few governments seem inclined to experiment with less capital intensive technologies. On the other hand, most of these governments want to diversify and expand their industrial base. But

even modest additions to industrial investment may entail relatively large and costly additions to the supply of fuels.

Developing Country Responses to the Energy Crisis in Industry

With the steep rise in energy prices, some negative responses from developing countries have emerged. One of the most serious is the accelerating trend towards the use of wood and charcoal in urban areas even in areas such as industry where oil had previously been used. This has already occurred in some Sahelian countries due to the very high cost of imported oil, especially in the landlocked countries of this region. In addition to relatively high existing household consumption of woodfuels demand in urban areas, this new increment of industrial energy demand for traditional fuels has led to a significant increase in employment of rural dwellers and people in the informal sector in the production of charcoal and its transportation to the cities. In some countries, this activity even seems to becoming a signficant part of the GDP.

Government and private industry management are often crucial in investigating the possibilities of using different and cheaper fuels or in conserving such fuels. More and more developing country governments are recognizing the importance of improving energy efficiency, especially in industry. In Kenya, which is a heavy importer of oil and one with large plans for heavy industry, considerable interest already exists in improving industrial energy productivity. But while interest may exist, contradictory policies in different departments may negate these intentions. In the Kenyan example, although firms are allowed to cogenerate heat and power, only one non-agricultural industry now does so and this one is not allowed to sell its excess electricity back to the national power utility or other customers--a considerable disincentive to undertaking the capital investment in cogeneration equipment.[24/]

Following the oil price increases of 1973-74, Korea instituted an industrial energy conservation program under which technical staffs were trained to perform

"heat audits" with the goal of reducing industry's fuel requirements by 10 per cent. Though, the auditors did their job well, program funding was very limited and relatively few audits were done. Moreover, the recommendations resulting from these audits are only "indicative" and unenforceable, considerably undermining the effectiveness of the program.[25/]

Multinational firms and domestic firms with access to new and more efficient technology or energy management techniques can generate considerable savings in developing country industries if the costs are favorable and there is a willingness to try. Again, drawing from one Kenyan experience, such a policy leads to good results. In the particular Kenyan firm, a pound of rubber tire was being produced with a total energy input of 18,719 Btus in 1975, higher than that multinational company's world average (13,400 Btus) as well as that of its operations in South America (11,000 Btus), although lower than in the U.K. (19,000 Btus). Yet, in only three years an aggressive Kenyan conservation program, was able to bring the energy costs of producing a pound of tire down to only 12,174 Btus, a savings of 35 per cent.[26/]

Other developing countries, especially the more advanced industrial and balanced growth economies are investigating new alternative fuels, e.g., Brazil's bioalcohol program and its research into solar energy applications for industry, and India's investigation of a wide variety of renewable options. In one illustrative application, a large dairy cooperative in Anand, India, has successfully installed a solar thermal pre-heater for its milk dehydration process in order to conserve diesel fuel supplies. But, the potential in this area has been barely investigated yet.

Other countries have reacted to the energy criris by switching back to fuels used previously. Thus Korea, as noted has, begun a large reversion back to the coal it was using in the early 1960s.

B. Informal Sector

Informal commercial enterprise constitutes a large and very important sector of both urban economic activity, in general, and urban energy use in particular. By its very nature, though, it presents problems of analysis in terms of definition, data gathering, and quantification. First of all, it does not represent a clearly distinct set of economic functions, but rather one end of a perforce somewhat arbitrarily divided spectrum. Second, two of the principal characteristics distinguishing informal from formal sector activities are that the former is relatively unorganized and that its activities are rarely reported to and recorded by governments. For these reasons, quantitative descriptions, found in studies, of the size and nature of this sector must be taken, for the most part, as relatively rough estimates. Likewise, comparisons between the findings contained in a number of studies and attempts to aggregate from these findings a uniform protrait of a homogeneous "Third World informal sector" must be regarded as limited in value. Nonetheless, whatever the intractability of this category for analysis, its magnitude and importance require that it be treated as a separate heading in terms of economics and energy use.

For our purposes, we will loosely define the informal sector as including those individual or group commercial enterprises which are characterized by most, if not all, of the following qualities: high labor and low capital intensity, self-employment, irregular hours, erratic work conditions, use of simple capital and/or traditional forms of technology, and a relatively high degree of labor mobility. Some of the principle forms of activity within this sector are provision of domestic and other services including repairs, manufacture by artisans

and craftsmen and craftswomen, small shops and street vending, and informal transportation services (to be discussed in the transportation section). Below we discuss several of the contributions made to the economy by the informal sector.

First, informal enterprises, in the aggregate, contribute a major, if impossible to quantify exactly, portion of GDP in all developing nations and, in most Third World cities, may account for upwards of 90 per cent of the total number of manufacturing and service sector establishments, and half or more of total employment.[27/] In all cases, informal sector activity employs far more labor and drains off far less scarce capital proportionally than does the formal sector, in general, and large-scale industry in particular. Many of those employed in this sector--unskilled workers along with"secondary" family breadwinners just entering the employment market--chiefly women and teenagers--would be unable to find jobs elsewhere.

Second, goods and services which assist industrial and other development often are provided by the informal sector. Industrial firms often turn to informal "subcontractors" for, among other things, construction work; the manufacture of simple spare parts which would be expensive and time-consuming to import; the provision of low cost raw materials, especially recycled materials; and cleaning, maintenance, and other services a portion of which would, in more advanced economies, be replaced by commercial energy-using machines. In addition, the informal sector provides industry with a ready pool of skilled and semi-skilled labor for temporary needs and large-scale projects requiring many workers, like a new road.

Third, informal sector enterprises are invaluable to developing economies in that they provide urban populations and especially the poor with goods and services priced and designed to meet their needs. The exact relationship of informal sector goods to import-substitution industries using large-scale modern technology, and the amounts that each contributes to national consumption goods is a particularly

thorny problem with probably significant variation from country to country. There is some speculative evidence that informal sector activities allow some large industries to produce a larger proportion than they otherwise could of foreign exchange earning and services. Hence, the informal sector plays a vital intermediary role in some developing economies: mediating, in effect, between what might otherwise be contending priorities for export-led development and the satisfaction of basic needs.

Fourth, the growth of informal sector activities is compatible with and supportive of agricultural as well as industrial development. In both large cities and rural villages, artisans are responsive to farmers needs for simple, cheap, and durable tools. By directly employing or at least creating room in the cities for surplus agricultural labor, this sector absorbs the brunt of rural-to-urban migration and moderates the (rural) population pressure on cultivable land. In fact, in some cities such as Jakarta, informal sector work is, for many, essentially off-farm employment. Through a "circulatory migration" process, a farmer spends part of his year on the farm and part of it working in the city to supplement his income.

Fifth, in the informal sector, human labor is generally substituted for commercial energy as well as capital. The operator of a rickshaw, for example, is unable himself to provide or obtain loans for capital investment in an automobile and the licensing and other fees necessary to become a taxi-driver, but he can at least obtain an income, however meagre, and perhaps save towards a down payment on an auto by providing a useful, generally affordable, and energy-conserving service. Domestic servants are perhaps the simplest example of substitution of human labor for energy. They substitute for the "energy slaves"--home electrical appliances of all kinds--which have largely replaced servants in the home of developed nations over the last few decades. Particularly in Latin America, domestic service workers constitute a large portion of total informal sector employment. A 1970 survey of

the urban "traditional" labor force in Peru, for example, showed that 12.7 per cent of workers in this group were employed as domestic servants.[28/] In Brazil, over 15 per cent of all service (tertiary) sector workers are paid domestic servants--an occupation considered part of the informal sector. Moreover, the proportion of such workers in the service sector is increasing fastest in the larger, rapidly growing cities such as Sao Paulo.[29/]

Sixth, in addition to subtituting labor for energy and capital, activities in the informal sector generally employ a high ratio of traditional fuels to modern fossil fuels and electricity. The process heat required for small-scale baking and brewing operations in most cities, for example, is generated, for the most part, by wood and charcoal in traditional ovens. Small restaurants may be "modernized" by electric lighting and radios or cassette recorders, but the bulk of their energy use is in the form of woodfuels for cooking.

Seventh, a sizeable portion of informal sector activities--those devoted to manufacturing new products in part or whole from previously used and discarded materials and those which prolong the life of products through repair services--may be seen as deriving their economic justification from conserving energy along with other resources. Informal sector recycling activities are widespread throughout the Third World and take an astonishing variety of forms. An almost ubiquitous example is the use of worn-out auto and truck tires as soles for low-cost sandals. Tin cans and other metal refuse are nearly everywhere reused in a variety of goods, from charcoal burners to siding for cheap construction. In many Asian cities, discarded school classwork and homework paper becomes packaging for street vendors and shopkeepers. These and myriad other recycling practices obviate the energy and resource expenditures which otherwise would be necessary to manufacture new materials for the same uses.

In similar fashion, the large numbers of informal sector laborers who earn their livelihood by providing repair services conserve energy by forestalling the need for manufacture of new goods. Repairs in nearly all developing countries extend the useful lives of products of all kinds several times beyond the spans of comparable goods in the "disposable" societies of the developed world.

If the informal sector moderates the energy problems of most economies by substituting labor for commercial energy and by conserving resources, it also creates problems through the inefficient use of traditional fuels. We are not aware of any estimates of the portion of total traditional fuel consumption accounted for by the informal sector, but it must be considerable in most cities. As in the residential sector (discussed below) much of this use must be classed as waste, due to inefficient combustion methods.

C. Large Commercial Enterprises and Government Services

Large commercial enterprises are here distinguished from industry--both large and small scale--in being primarily a part of the so-called "tertiary" sector. In a Third World city, these enterprises are likely to include retail trade establishments, shops and markets, government and private company offices, schools, hospitals, hotels, restaurants, and other similar entities. Most of these establishments do not produce goods, (with the partial exception of restaurants) but provide services. As a result, their energy use is mostly drawn from public utility services (electricity, water, and sewage) and the embodied energy in construction materials and equipment, which is discussed separately. In some cities, the distribution of fuels like natural gas and fuel oil is controlled by utilities or state owned companies, but in most places, the provision of combustible fuels does not appear to be treated as a utility. However, in many Third World cities, the conditions of sale of various kinds of fuels are regulated by the government. Many governments keep the price of kerosene artificially low through

subsidies. In other areas, the use of certain fuels may be prohibited, for example, the use of charcoal in Jakarta (owing to the deforestation problem there).

Modern large commercial enterprises are part of the modern formal sector of the economy in that their activities enter into national accounts as does the energy these enterprises use. This is probably even the case with much of the traditional fuel used, for example, in large hotels and restaurants. However, as noted in the previous section, many of the maintenance employees of these businesses and even of government offices frequently come from the informal sector.

As in the West, most Third World modern commercial and government buildings and businesses have been planned and built with little consideration for their associated energy costs either in building materials or operating services. (Building materials are discussed in the "Construction" section of this chapter.) However, the energy relationships between materials, building design, and operation is naturally very close.

In a developing economy with a limited power infrastructure, the costs of providing energy services to the commercial and government sector can be high. Even in the United States, the energy used by this sector just for heating and cooling, lighting, and other power needs for commercial buildings amounted to 13 per cent of national energy consumption in 1976.[30/] This figure would go up somewhat if other infrastructural services (sewage and water) were factored in. In the developing countries, these same end uses may require at least this much and probably more--most of it in the form of electricity. One study, for example, found that air conditioning alone accounted for between 30 and 60 per cent of total low voltage electricity consumption in the capital cities of the Sahelian countries of West Africa which are usually the largest cities in these countries.[31/] Industries tend to use most of the high voltage electricity in these countries.) The modern Hotel Ivoire in Ivory Coast by itself is the fourth largest electricity

consumer in the country using about 2 per cent of national consumption.[32/] This in one of Africa's most economically dynamic economies, too. Even in a much larger economy, like India, electricity for commercial and public services amounted to nearly 10 per cent of total electricity consumption (1971-2).[33/] Although these figures are partially explained by the lower total electricity consumption of developing countries, and its concentration in cities the relative cost to these economies is still likely to be very significant.

Electricity for lighting and space conditioning undoubtedly improves productivity in the workplace and provides comfort as well as power in service-providing enterprises (hotels, restaurants, cinemas, etc.) However, given the tremendous financial constraints facing the expansion of electricity systems, inefficiency among commercial customers that raises their electricity consumption hinders the ability of utilities to meet existing and, increasingly, new demands for electricity. This is particularly a critical problem for countries that generate a significant portion of their power from imported oil. Hospitals in Turkey, for example, have taken to restricting the number of operations they do for fear of blackouts caused by insufficient fuel to generate municipal power.[34/] New demands for power are growing at a rate of 10 to 20 per cent in many urban area. Even in countries with high cost electricity supplies, many of them in tropical areas, modern buildings are often designed extremely poorly or for the totally different climate of temperate countries and hence require enormous amounts of air-conditioning. Typical building design problems include: thin walls (insufficient thermal mass), inadequate solar shielding (awnings or reflective coatings) on walls and windows, badly closing windows, absence of thermal insulation, too much window surface (which turns a building into a greenhouse if the air conditioning breaks down), insufficient natural ventilation, and careless operating habits like leaving windows and doors open in hot places, air conditioning empty rooms and not making routine preventive

maintenance in energy generating and energy-using machinery.[35/] Other problems include the purchase of inefficient equipment (often mistakenly) because the initial investment is cheaper. Usually, the higher operating costs of cheaper equipment quickly erase the initial capital cost savings.

The provision of water supplies--both of the public standpipe variety and individual building plumbing, sewage and waste systems--and roads represents a heavy capital investment. Operating costs in terms of energy are not large (except for roads), but the embodied energy in materials is quite signficant and probably accounts for a large proportion of these costs.

For many Third World cities, the extension of services is a staggering task. With populations doubling every 10 to 15 years, existing systems become quickly overburdened and the extension of new services can never catch up. Meanwhile, the poor must bear the burnt of ad hoc service substitutes and in water supplies, in one example, have had to pay as much as 25 times the rate paid by more affluent residents who have plumbing.[36/] Manila and the other large Philippine cities, for example, have sewage systems sufficient for only 25 per cent of the population, and a public water supply for only 60 per cent of their total urban population. Calcutta, a city of over 8 million people, has a water and sewer system which was installed nearly a century ago for a population of 600,000.[37/] One South Asian city has an extensive water supply network but 40 per cent of the water is lost in distribution due to poor maintence.[38/] Outhouses are common, waste pollutes drinking water, and garbage collection is an ad hoc affair. Less than 10 per cent of the homes in Manila have telephones.[39/] Even if a government decides to extend services like sewage and sanitation, the cost of a hookup to the system for the poor is completely prohibitive.[40/] Despite some exceptions such as nearby

Singapore with a modern sewage treatment system that serves the entire urban population enourmously expensive modern water, sewage and sanitation systems will continue to be inadequate in meeting the demand of services in most Third World cities.

D. Household Energy Use

1. Introduction

Statistics describing urban household energy use, supply, and needs are scarce. This analysis draws largely on the few household studies available.[41/] In addition, some data can be found in a number of other studies not specifically concerned with urban household energy.

The lack of data is compounded by the varying ways in which household energy is analyzed. Gross energy input amounts applied to the performance of a task cannot describe the amount of useful energy output obtained, either in the efficiency of conversion from primary to useful energy or the efficiency with which that useful energy is applied to cooking, more heating or lighting, for example. Thus, subsidized electric hot plates may be cheaper and more efficient than charcoal braziers at cooking but the energy expended to generate and transmit that electricity and the embodied energy costs of the hot plate (not to mention the money cost) may negate the latter's technical advantage.

Almost a quarter of the developing world's urban population lack even the most basic of services.[42/] Many more have less than adequate provision for their residential needs for heating, lighting, cooking fuels, clean water supplies and sanitation facilities. Until recently, the critical role that energy plays in meeting household needs and tasks was neglected. But household energy is both essential and, currently, very costly, even to meet minimal needs.

Household energy requirements here, are taken to include those needs a household tries to provide foremost, irrespective of income. These are heat-related needs: cooking, space, and water heating. Also, even the poor try to obtain energy

for some power needs (mostly electricity, but also other fuels) for lighting and amenities.

Household energy use is important in developing countries both in supply and demand terms. On the demand side, it has been observed that one quarter or more of an urban developing country household's budget may go to the purchase of fuels for cooking, waterheating, lighting, and other energy-using tasks,[43/] (the figure would rise substantially if the embodied energy cost component of food and other goods consumed within the home could be reliably identified.) In rural areas, household energy use comprises the overwhelming use of traditional fuels. Taken together, and especially given the poor conversion efficiency of most traditional fuel use, roughly one half of national energy consumption in most developing countries occurs in households (urban and rural).

Looking at how this energy is supplied indicates that urban areas' share of this is accelerating in many countries. While per capita urban energy consumption may be lower than in rural areas on the basis of the heat content of fuels used, in fact, traditional fuels are converted so poorly that the useful energy supplied to rural households in probably substantially less than in urban areas. Households in cities and towns tend to use higher quality energy like electricity, and charcoal, which deliver more useful energy than wood.

Urban energy use is also increasing because per capita consumption of energy tends to increase as per capita incomes increase (except at very high income levels.) Even poor urban dwellers often have higher incomes than the average rural dweller. Rises in income also lead to subtitution of higher quality energy forms like fossil fuels and electricity. This is contributing to the tendency for a greater fraction of energy investment to be used for supply in the needs of cities. The capital costs of providing this energy (generation equipment, refineries, distribution systems) and--for oil importers--the costs of fuel have added significantly to foreign

exchange outlays for energy in many developing countries (though the proportion of such expenditures attributable to household demand would be hard to specify.)

2. Cooking and Water Heating

Richard Meier contends that more than half of Third World urban energy use is associated with food consumption.[44/]

Certainly, the energy expended at the household level on cooking is a major portion of household consumption. Likewise, the heating of water for bathing, laundry, and incidental needs accounts for a significant amount of energy use in many homes. Especially at lower income levels, these two modes of consumption are indistinguishable; the same fire that cooks the stew, often heats water to wash the dishes and clothes. It is assumed here that most of actual household energy use is for cooking, but the exact proportion allotted for the two kinds of tasks is unknown precisely in available household survey data. Accordingly, unless otherwise stated, where a study has given separate figures for the energy use involved in these two groups of tasks, we have assumed them as being one: cooking and water heating.

In Mexico City, cooking and water heating represent over half of the direct energy use of the average household. The exact portion of total consumption for a given home appears to be more closely related to income level than to any other single factor. Thus, in the houses of the poorest income class these two tasks accounted for three-quarters of total household energy consumption; in those of the richest, it was less than half.[45/] In Nairobi, while the average household energy consumption for cooking and water heating was also over 50 per cent, this figure concealed a greater variation than that for Mexico City. Among the poorest two of five income classes surveyed in Nairobi (representing by far the majority of the population), 90 per cent of home energy use went to cooking and water heating; among the richest class, the figure dropped to less than one third.[46/]

The source of the energy used for cooking and water heating appears to be even more dramatically affected by differences in income than the percentage of total use accounted for by these tasks. This was strikingly demonstrated by the Nairobi survey, which found that, among the poorest class, 60 per cent of the energy used in cooking and water heating is provided by woodfuel whereas among the richest class, over 90 per cent is provided by electricity. Liquid fuels appear to play an intermediate role, rising from 40 per cent to 63 per cent from the first to the third income group, then falling away to 3 per cent in the richest group.

Less statistically comprehensive data available for a wide range of other Third World cities indicates that the general pattern found in Nairobi is fairly typical. The poor burn wood and charcoal for their cooking and water heating needs, while those with the wherewithal to do so use kerosene and bottled gas with a preference when possible for electricity. With individual variations, this is the pattern for cities as diverse as Nakon Nayok (Thailand), Lome, Maseru, Bagabag (Philippines), Ouagadougou, Butembo (Zaire), and Tangier. In many cities, the poor also use significant amounts of dried animal dung and vegetable residues such as coconut or rice husks as well.[47/]

Household use of charcoal, currently requires a greater total energy system input than does direct use of wood despite charcoal's greater useful energy output. This is because most wood is converted to charcoal at a very low efficiency--25 per cent or less--and thus much more wood is needed to supply heat via charcoal than would be the case if wood was burned directly. Moreover, surveys indicate that charcoal is much preferred over wood among large portions of the urban population (mostly poor people). Until very recently, (and only now in some countries) its total energy costs have not generally been reflected in its market price and it remains cheaper than

commercial substitutes like kerosene or electricity (except where these have been provided with heavy subsidies.) Hence, continuing oil price rises and the slowdown in urban and rural electrification have increased the popularity of charcoal vis-a-vis these substitutes. One result is increasing deforestation of many urban and some rural areas. Ironcially, this may now force the raising of charcoal prices in many towns and cities.

3. Lighting

The Mexico City and Nairobi studies are useful in this area in that they give some idea of the tremendous disparities in energy use for lighting between the poor and the rich. The figures they report suggest that high income households may use on the order of 3 to 8 times more energy for this purpose than poor households. This is certainly confirmed by reports from other cities. However, there appears to be a considerable variation in the forms of energy used for lighting. A number of surveys and reports indicate that electricity is not the predominant source of lighting at all income levels. Indeed, lighting in the form of kerosene lamps and candles occurs widely in the slum sections and shantytowns of practically all Third world cities. Lighting needs are also reflective of adaptive behavior: in especially poor households most activities requiring good lighting seem to take place outside or at least during the day (e.g., using open windows and doors.)

4. Space Heating and Household Appliances

It is easy to underestimate the significance of this area of the household sector, both in terms of proportional energy use and as an aspect of the struggle for survival of the urban poor.

In the first place, it is generally taken for granted that the proximity of many developing countries to the equator means that Third World climates are invariably warm. Actually, of course, temperature is affected by many factors including altitude, prevailing winds, desert climate, and nearness to warm or cold bodies of water. Hence, although there are many Third World cities in which space heating is not a problem, there are probably almost as many in which it is. A sample list of cities where--on the average--temperatures descend below 45° F for at least one month of the year includes Tehran and Kabul in Central Asia; Ankara and Damascus in the Near East; New Delhi in the Subcontinent, Addis Ababa and Casablanca in Africa; Chungking, Peking and Seoul, in East Asia, and Mexico City and Quito in Latin America.[48/]

Unfortunately, there have been no studies done, to our knowledge, of space conditioning--especially heating and associated energy use in Third World cities. However, one measure of the importance of this activity in the energy needs of the urban poor can be inferred from an estimate, cited in a recent study of wood energy that annual per capita consumption of woodfuels for cooking and heating may be more than 4 times higher in upland than in lowland regions of Africa. Even allowing for the extra heat needed for boiling water at higher elevations, these figures imply that in an upland household of 4 persons, at least 6 cubic meters of air-dry wood (equalling 18 million kilocalories) are used every year for space heating.[49/]

In addition to woodfuel used for heating among the poorer and middle income classes, it must be assumed that wealthier urban households consume an equivalent amount of energy in the form of oil and electricity for heating purposes. While figures are not available to substantiate these conclusions, it appears reasonable to suppose that household energy needs for heating as well as the forms of energy used are also closely related to income. This is largely due to the wide range of opportunities for fuel conservation available, especially to the poor. During cold weather, warmer clothes may be worn and household activities confined to one room, usually the kitchen. In large urban compounds in some areas, enclosed livestock shelters may adjoin and thus add to the warmth of living areas. In Afghanistan, families stay warm under "sandalis", quilts centered over small charcoal-burning heaters.

The rapid growth of space cooling demands for energy in many tropical Third World cities with important developed sectors is worthy of note. It may be a significant increment to household demand for electricity among the more affluent who can afford fans if not air conditioners.[50/]

Electricity consumption associated with the use of household appliances, (e.g., refrigerators and radios) appears, in most cities, to be largely confined to intermediate and upper income groups. In the survey of household energy use in Nairobi, one of the poorer developing cities, (though not the poorest), no use of electric appliances was reported in the bottom two of five income groups. Above that level, however, appliances accounted for 25 per cent and more of total energy consumption. In Mexico City, an advanced developing country where electricity is more uniformly and cheaply available, less than 10 per cent of household energy was used for appliances by the poorest class; among successively wealthier classes, the figure rose rapidly to over 30 per cent.

E. Construction

The construction sector in most Third World cities is a very important source of employment and, as we have seen, one of the bridges between informal sector and formal sector employment. Construction activities, of course, are the means by which a city builds its infrastructure of housing, services, roads, and commercial and industrial buildings. Hence, it is an indirect indicator of the dynamism of at least the metropolitan economy. Moreover, evidence suggests that construction activities have a fairly strong multiplier effect on other areas of the urban economy, chiefly in the provision of materials and employment of labor--a process in developing cities often charaterised by a great deal of subcontracting and task specialization.

The critical issue in construction, (as it is in most other economic undertakings), is how to get the most output, (number of housing units, factories, roads, sewers) at the least cost. Construction activities appear to be very sensitive to costs, especially with regard to the costs of energy embodied in construction materials and the amounts and kinds of labor used. This sensitivity to costs is one reason why there has always been a wide range of possibilities for substituting less

energy intensive materials and of using more labor by changing construction methods. This can be readily seen in contrasting construction practices in many developing cities with modern materials and construction practices used for some kinds of projects, improvised and recycled material together with labor-intensive building techniques used for others.

The development plans of many countries have exhibited a clear bias in favor of high cost construction. This can be seen in the nature of building codes and designs and the proportion of investment allocated to projects using modern construction practices. Construction practices using high cost equipment have probably been a hindrance to increasing the rate of growth of construction needed to meet either the country's own overall development targets or the targets in areas such as housing and infrastruture including sewage, water systems and roads.

There are several energy-related urban construction tendencies which most developing countries share. The first is the adoption of building designs and building construction codes that are inappropriate for the locality and may unnecessarily add to a project's costs. This applies to both residential and commercial structures and some kinds of infrastructural projects. Second, and in part a result of the first problem, is the use of high-cost, relatively energy intensive building materials when locally produced, low cost, less energy intensive materials could be employed. Third, modern international urban construction practices tend to be equipment intensive and may not take full advantage of plentiful low-cost labor. The combination of inappropriate standards, building materials, labor practices may be very important in preventing developing countries from meeting their housing and infrastructural needs.

Building design and construction codes. Many, if not most, developing countries have shown a clear preference for Western or "international" building designs

and materials for their modern commercial, industrial, and infrastructural facilities. In addition, much upper and middle income and even public housing projects incorporate these designs. Apparently until recently, little consideration was given as to whether these designs "fit" the prevailing local architecture or whether they properly factored in the local cost of the energy services required to operate the building or sewage system or the embodied--and frequently imported--energy in the building materials and associated machines.

Until recently the Western, industrialized nations often did not bother to include the "life-cycle" energy cost of these modern construction materials into architectural design. Thus, builders have and continue to put up commercial office buildings, that are thinskinned and overlighted and have many large unshaded windows. Usually they are not only more expensive to build than an energy and resource-conserving structure but require far more operating energy, that is, they have high life-cycle costs.

Even within the framework of modern building design, there is a significant range of technical energy standards applicable to these kinds of facilities. To give but one example, a change of office lighting standards from 800 lux to 1200 lux not only adds about 50 per cent to the cost of light fixtures but also entails a sizeable cost in associated cables, switch gear, and air-conditioning (necessary to remove the heat given off by the fittings) in addition to the energy used in the manufacture and operation of these items.[51/] Often, developing country building codes have unnecessarily adopted detailed material specifications for construction projects from Western countries instead of using final performance specifications or ability to meet end-use criteria. This problem is compounded by the fact that the energy crisis has shown that these imported designs are often grossly energy wasteful even in their country of origin. A very high capital cost structure

Table 6

Materials Used in Modern Urban Construction in India in 1964

Inputs	Percent of Total Inputs
Non-industrial materials	8
Iron and steel, non-ferrous metals, metal products	25
Cement	7
Ceramics, bricks, glass	9
Wood products, timber, other forest products	12
Petroleum products, paints, etc. (pre-1973)	2
Total material inputs	63
Value added (labor)	37
Total inputs	100

is almost always a high energy user as well.[52/] Possibilities, however, do exist to economize by selecting designs that save energy.

For public works projects, especially in the area of low income housing, appropriate building designs should reflect the needs and incomes of those for whom the designs are intended and also reflect the social development strategies of the country. With few exceptions, most developing country governments have failed to come up with low cost, energy efficient designs that can meet the rapidly burgeoning demand for decent housing. In fact, some practices simply compound the problem. In the case of Abidjan, the capital of Ivory Coast, for example, the dwellings of about one-fifth of the city's inhabitants were razed between 1969-73 and their occupants displaced in order to build new housing. In most of the cases, the new housing was less dense than that which it replaced and more costly, permanently displacing a portion of the previous residents. In addition, the razing of these poor neighborhoods also destroyed the economic fabric of these neighborhoods especially the informal sector activities which had given employment to many in the area.[53/] Often, governments intend this as a means of discouraging urban migration and the informal employment network that allows these migrants to adjust to the city's work environment. However, the usual result has simply been to push these people out onto the city periphery with little apparent slowdown in migration.[54/]

Building materials. While construction activities mirror the pace of economic development, they also reflect, as we have noted, imported development standards, whether or not these standards are appropriate to the country's level of development. This is a particularly serious problem in regards to building materials. In case after case, in developing countries, the cost of building materials exceeds the cost of labor in total project costs by a substantial margin, sometimes by more than two times.

Modern design standards may require the use of high quality (and energy intensive) building materials that often must be imported. For some developing countries, this amounts to exporting raw materials like wood, iron ore, and copper only to ultimately re-import them in the form of higher cost construction materials (amongst other goods). Whether sufficient investigation of using domestically-produced and suitable alternatives is ever undertaken is doubtful in many cases.

Standard government housing building materials requirements can be very expensive. In the case of Bhutan, for example, these standards in effect require that 80-85 per cent of construction costs go towards materials of which 64 per cent must be imported.[55/] Most of these materials, like concrete and steel, are also very energy-intensive and their relative costs can only continue to rise sharply in the future. The composition of inputs in the Indian construction industry (1964) shows the relative dominance of energy-intensive material use in modern urban construction (Table).[56/] Non-industrial—in this case mostly non-energy intensive materials-comprised only 8 per cent of total materials used. Moreover, the secondary round of demand to supply these materials (oil to make the paint, coal and iron for steel, etc.) may also add to the foreign exchange burden of a country. In the case of India again, while the proportion of local to imported materials costs of finished building materials was about 70:30, factoring in the cost of the inputs to make those goods raised the import proportion to half.[57/]

Given the kinds of normal capital constraints found in most developing countries and the high costs of energy-intensive building materials, it is not surprising that the pace of modern construction activity has failed to keep up with demand for suitable structures. The opposite case holds for the erection of dwellings in slums and shantytowns. While the proportion of building materials' costs in these cases seems relatively high, it is chiefly a reflection of the very low proportion of labor costs especially skilled labor that are needed. Indeed, most slum-dwellers

either make their own houses (or do so as part of a group effort) or make modifications in existing dwellings (e.g., adding internal partitions or outside additions.) Many shantytowns are characterized by the use of light and recycled materials (tar paper, used shipping cartons, old corrguated metal roofing, for example). The amount of new energy intensive material used is difficult to ascertain since data is lacking but it is probably very small. Many dwellings in the poor parts of urban areas employ mudwall construction, wood, bamboo, thatch, stone, and clay tiles to name just a few of the kinds of building materials. In fact, much poor urban housing represents an adapted form of the kind of rural housing in that country: housing which often evolved over centuries of adaptation to climate and the availability of materials. In many cases, some improvements in building techniques may be enough to make these dwellings into suitable low-cost urban housing (see Chapter III). As it is, much squatter housing is characterized by a continual evolution in improvements as poor income-owners try to upgrade their own housing. For example, in the "Alagados" slum in Salvador, Brazil, houses begin as palafitas, huts built out of scrap on stilts above garbage fill dumped into the bay and connected by an intricate series of wooden bridges to other houses. After about 10-15 years, these houses have been rebuilt on more solid (land fill) ground with mud streets. The houses have been reinforced with lumber, have cement floors, wooden shutters, and a tiled roof. Outhouses exist. More elaborate furniture is found. Water is stored in fiberglass or cement rooftop tanks. In another 5-10 years, the same house will probably be on firm ground partly or wholly rebuilt with cement block and may even be multistoried. It will probably have electricity and some modern appliances. The streets will be paved. Indeed, the neighborhood may become almost middle-class and yet the status of the resident may still be considered by the local government to be that of an illegal squatter.[58/]

Table 7

Value and Floor Area of Different Categories of Structures in Manila, 1974

Category	Percent of Total Floor Area	Percent of Value of all Structures
Modern	38	55
Intermediate	10	10
Conventional	50	34
All Categories	98	99

Construction Labor. Unlike heavy industry where the substitution of labor for energy is inherently limited, construction energy use is dependent more on the costs of labor and the construction firm's and government's policies on the use of labor. Thus, in China, masses of people are mobilized to literally move mountains. Likewise, in India, the building of dams and irrigation canals employ large amounts of laborers. These large infrastructural projects stand to gain obvious cost and employment benefits from using large numbers of temporary, unskilled labor.

In the specific case of the urban building construction industry, the substitution of skilled and unskilled labor in place of machinery, in many cases, seems to depend more on the kind of building to be built than on any set of economic cost-benefit criteria. One survey of Manila looked at this question in detail.[59/] It divided the housing market into three categories. A fourth category corresponding to slum and squatter dwellings was noted but data was lacking on its construction characteristics. A comparison of the value of the buildings versus the actual floor space each contained (Table 7) provides a rough approximation of the relative building material and labor costs in each category.

The first group, "the modern" building sector, was characterized by large firms which worked closely with government on high rise and non-residential buildings. Having access to cheap credit, they tended to employ Western construction techniques and large amounts of power equipment. The building firms working in the "intermediate" market, building luxury apartments and medium-sized non-residential structures, showed a much higher labor component and the use of small equipment such as concrete mixers, hoists, and concrete vibrators. The "conventional" building firms constructing smaller residential and non-residential buildings were mostly independent groups of skilled and unskilled workers. Unlike Western contractors, the individual building contractor provided only the labor; the owner purchased all materials. Independent building groups worked in a very competitive environment with many other

similar groups. Other than hand tools, they used little or no modern construction equipment. The bulk of their laborers came from the poor "barrios," though, unlike most other developing countries, they were considered part of the formal sector since the labor value of all construction activity that has a building permit is included in national accounts. A typical independent construction gang had a foreman, a permanent core group of skilled workers and a varying group of temporarily employed unskilled workers.

In many other developing countries, many small enterprises that would be included in the construction industry, are a large component of the activities of the informal sector. In these countries, building costs (mostly reflecting the cost of materials and machinery) of a large portion of poor and middle class housing are kept down by using workers who earn less than the official minimum wage (where this is high than the equilibrium wage rate.)

F. Transportation

Transportation is of special concern in terms of urban and national development for two reasons. First, within the limits of each city's urban design (the spatial relations between industrial, commercial, administrative, residential, and other locations), demand for transport in a city can be viewed as a means of bringing together inputs to make outputs. In this sense, a city's capacity for growth is significantly affected by the ability of laborers to reach work-sites, materials to reach factories, consumers to reach markets, and businessmen to shift goods from location to location.

Modern development strategies clearly recognize the importance of transportation in the large amounts of investment by Third World nations in this area and in communications (a substitute for transportation in a sense) in the first two postwar decades.[60/] The World Bank estimates that the developing countries each year invest roughly 5 per cent of annual Gross Domestic Product in all transport sector activities.[61/] Within cities, transport activities commonly account for the largest shares of public investment budgets. In Bombay and Calcutta, for example, transport outlays accounted for 26 and 48 per cent of total planned investment between 1972 and 1978.[62/]

Transportation is of equally critical importance for the poorest classes in their efforts to fulfill their basic needs. Access to efficient and affordable transport facilities means access to jobs and markets. Lack of roads in an urban fringe area may preclude the local establishment of schools, water, electricity, sewage, health centers, and other services.

Yet, despite transport's key role in terms of basic needs and urban and national development, unnecessary and costly transportation mistakes are being made. The World Bank has noted, "On present trends, the cities of the developing world risk to repeat, and in an exaggerated manner, the shortcomings of urban transport . . . of the cities of the developed world."[63/] Urban public transport systems are nearly uniformly

inadequate and usually in a state of chronic disrepair. A large number of Third World cities--Lagos, Teheran, and Bangkok, to name a few--have succeeded in surpassing the greatest achievements of the West in the promotion of traffic jams. Yet "transport management, traffic officials, and urban planners rarely, if ever, meet, [in these countries]."[64/]

The forms of urban and inter-urban transportation of people and goods used and how well they work are vitally important questions to developing country governments because transportation, more than any other end-use sector is overwhelmingly based on oil--a depleteable resource. Modern transport demand--predominantly confined to urban areas and, urban-serving activities--may often account for as much as 3/4 or more of national oil demand. On present trends, this figure would appear certain to increase, since the nearly uniform tendency of transport sector development in Third World nations is for increasingly inefficient use of those transport modes which are most prodigal in their consumption of hydrocarbons. Hence, the rapidly growing costs of oil for transportation within and between cities constitute an increasingly serious constraint on national development plans especially of oil-importing nations and the aspirations of the poor in every country.

The great diversity of personal and public passenger transport modes available to Third World city dwellers--from foot, bicycle and pedicab to luxury automobile and bus is matched by the wide range of levels of end-use energy efficiency of these modes, measureable in terms of the number of units of energy needed to carry a single passenger one mile (see Table 8).

Table 8

Method or vehicle used for transportation	Energy use for a 100% load factor, Btu/passenger-mile	Average load factor in 1970, %	Average energy use in 1970, Btu/passenger-mile
Urban transportation			
bicycle	200	100	200
walking	300	100	300
mass transit			
bus (diesel)	650	18	3,700
electric (vehicles)	1,100	26	4,100
average	760	20	3,800
automobile	2,300	38	8,100
Interurban transportation			
bus	740	46	1,600
railroad	1,100	37	2,900
automobile	1,600	48	3,400
airplane	4,100	49	8,400

Note: Data is for the U.S. in 1970.

Sources: S. S. Penner and L. Icerman, Energy, Vol. 1: Demands, Resources, Impact, Technology, and Policy, (Addison-Wesley, Reding, Mass.) 1974, p. 253.

Some of the most interesting comparisons in this table have to do with urban transport modes. Note that bicycles are almost twelve times as efficient as cars used within the city (at a 100 per cent load factor for cars). And, incredibly, the use of cars in urban areas was virtually no more energy-saving (on a per capita basis) than flying in an airplane. Even assuming that urban automobile use could be made twice as efficient with more appropriate vehicles than the typical American "gas guzzler", automobiles still fall considerably behind other forms of urban transportation from the point of view of end-use efficiency.

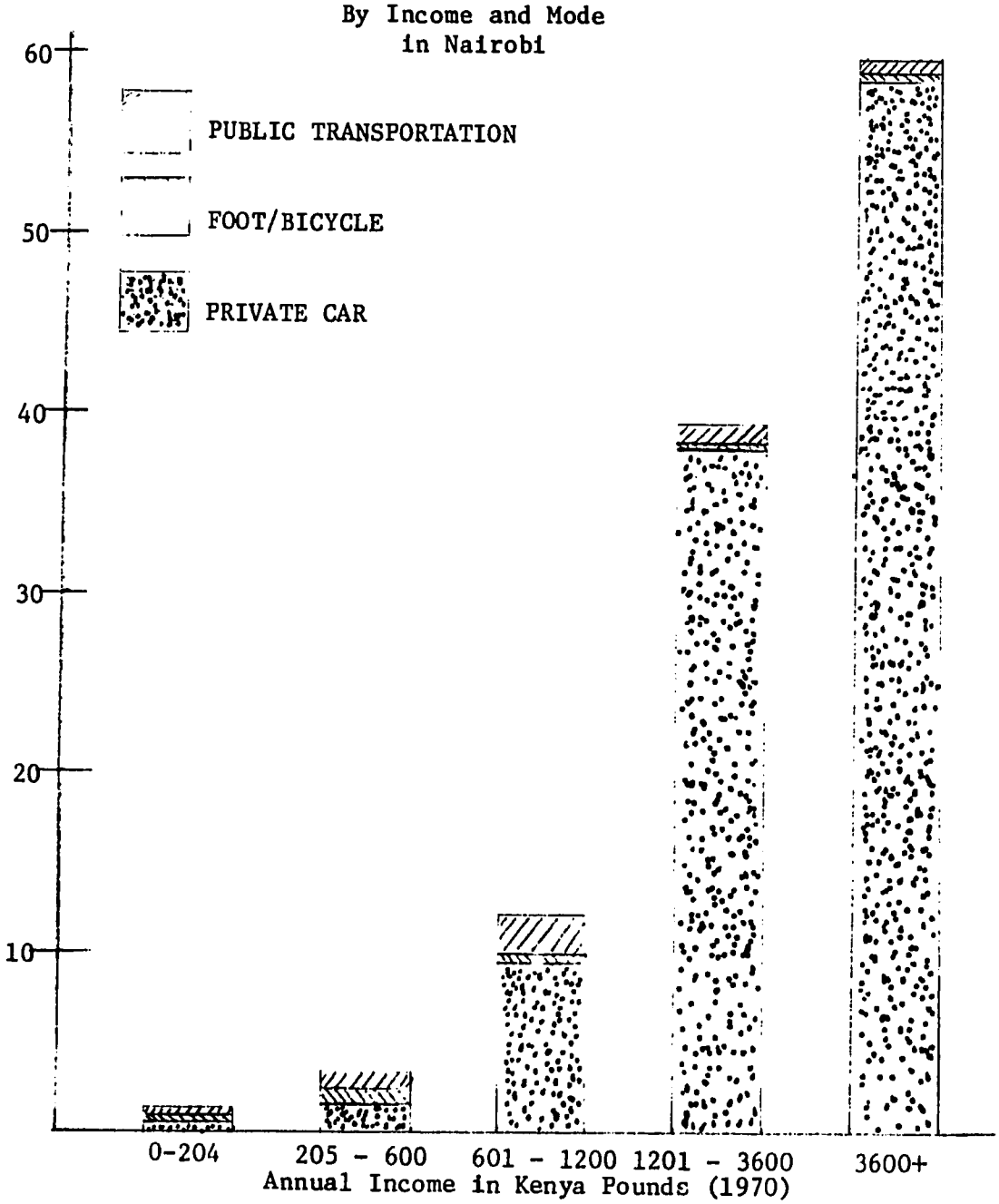
Currently, throughout the Third World, the tendency is for rising urban incomes to be closely related to increasing use of less energy-efficient transport modes. In Nairobi, for example, which imports all of its oil at great cost, nearly two-thirds of yearly passenger miles travelled by individuals in the bottom two of the 5 income groups, in a 1973 survey, were accomplished on foot or by bicycle. In the wealthiest group, on the other hand, only 5 per cent of passenger miles were travelled on foot and by bicycle, with transportation by private automobile rising to 90 per cent of the total.[65/] The portion of total passenger transport provided by public transportation diminished from over 35 per cent among the poorest group to less than 6 per cent among the wealthiest. As Table 8 makes clear, these changes in the modes of transport used by different income groups result in even wider differentials in terms of transport energy use.

Thus, despite the fact that only a small minority of Nairobians rely on automobiles for half or more of their transport needs, private cars account for more than 90 per cent of all passenger transport energy use. The extreme energy inefficiency of the auto in congested urban areas is responsible for the fact that within all but the poorest of the five income groups surveyed, it consumes

more than half of the energy needed to move people from place to place. This close relationship between higher urban income levels and use of less energy-efficient transport forms, especially private autos, is characteristic of all societies but is especially noticeable in developing countries where income disparities are much wider and the range of transport alternatives in terms of energy use generally far broader than elsewhere.

Table 9

-Transportation-
Fuel-Energy Consumption Per Household
By Income and Mode
in Nairobi



Source: IER, SUNY at Stony Brook, New York,

Table 10

Urban Travel Patterns by Income Groups

	Percentage of home based trips (Bogota, 1969)				
Income Group	Walk	Bus	Taxi	Car	Total
Low	55	40	5	0	100.0
Medium	5	70	15	10	100.0
High	0	10	10	80	100.0

	Percentage of all trips (Hong Kong, 1966)		
Monthly income (1966 HK $)	Public Transport	Taxi	Private Car
0-300	88.4	5.6	6.0
1,001-1,500	67.6	9.7	22.7
2,001-3,000	37.3	9.9	52.8
Over 5,000	14.9	12.8	72.8

Monthly income (1969 NT $)	Mode utilized (Taipei, 1969)
Below 1,000	Bicycle
2,000-3,000	Bicycle or bus
3,000-5,000	Bus, motorcycle, or taxi
5,000-20,000	Taxis, or cars
Above 20,000	Cars

The process of modernization and development--and its consequent urbanization process has also greatly accelerated the trend to motorization of transport, (see Table 4). Over all, nearly one-fourth of world growth in the number of motor vehicles of all kinds between 1960 and 1970 occurred in Asia, Africa, and South America.[66/] Though passenger cars still account for less than 60 per cent of the total number of motor vehicles in developing countries, the percentage is rapidly climbing towards the 80 per cent figure commmon in Europe and North America.[67/] This growing ownership of cars is heavily concentrated in urban areas. Teheran contains only about 10 per cent of Iran's population but 50 per cent of its automobiles. Jakarta, with less than 4 per cent of the population of Indonesia, accounts for 37 per cent of its car registrations. While only 12.5 per cent of the Ivory Coast's citizens live in Abidjan, they collectively own 70.4 per cent of the nation's automobiles.[68/]

Many projections for the future assume the current rapid pace of motorization will continue. Between 1975 and 2000, world demand for passenger transportation energy is expected to increase by at least 220 per cent, but the developing countries share of this demand may nearly double: from 12 per cent to 23 per cent.[69/] To achieve this proportion, the expectation is that energy consumption for passenger transport in the developing world during this period would nearly quadruple.[70/] Any attempts to moderate these prospects must deal with the increasingly predominant role in passenger transport and energy played by the urban automobile. Clearly, changing these patterns in an equitable and planned manner would seem to be more beneficial than letting future oil price hikes and supply shortages dictate changes.

As well as being the result of relatively intangible factors such as prestige, growth in dependence on the automobile on the part of those Third World city-dwellers who can afford one reflects the dangers and inconvenience of bicycle and pedestrian transport and the inadequacy of public transport systems.

Table 11

Relationship of Urbanization, Motorization, and Income

(1969-1970)

	U.S. dollars of GNP per capita	Percent of population in cities	Vehicles per 1,000 persons
Nigeria	100	20.9	2.5
Tanzania	100	6.1	7.3
Zaire	100	15.6	2.9
India	110	18.8	2.5
Indonesia	110	17.9	5.7
Kenya	130	9.7	12.4
Thailand	160	14.4	19.8
Senegal	200	27.3	12.0
Korea	210	48.8	4.0
Brazil	270	56.0	32.5
Colombia	290	57.2	13.3
Taiwan	300	64.4	55.3
Peru	330	52.5	30.6
Malaysia	340	45.0	61.1
Iran	350	40.6	17.0
Turkey	350	35.1	10.7
Mexico	580	59.5	38.9
Venezuela	1,000	76.4	76.0
Argentina	1,060	76.8	110.6

Source: World Bank Atlas, IBRD, 1971; Davis, Kingsley, "World Urbnaization", 1950-1970, Vol. 1, University of California, Berkeley, 1969; and Highway Statistics for 1970, International Road Federation.

The anarchy and congestion of traffic movement in most of the large and many smaller Third World cities is caused by a number of fators such as narrow roads, ill-designed for motorized traffic, inadequate traffic regulations and enforcement resources, a lack of signs and signals (and the literacy necessary to interpret some of them) and the dangerous mixture in traffic of a wide range of slow and fast moving vehicles along with pedestrians and domestic animals. Behind this array of visible problems are the root causes of the problem in inadequate or non-existent planning or even an absence of communication between the urban planning traffic engineers and transport ministers.[71/] And as in the case with other urban problems capital is scarce for improving transport infrastructure.

In all Third World cities, passenger trips on foot or by bicycle outnumber all other kinds combined over a surprisingly wide range of distances. In cities like Kinshasa and Dar es Salaam, two thirds or more of trips recorded in surveys have been on foot. In Africa and Asia, especially, as much as one half or more of urban trips of intermediate distance may be accomplished on bicycles.[72/] Yet, in most cases, no provisions whatever have been made to ensure the safety, let alone expedite the progress of cyclists and pedestrians. In the United States, it has been estimated that transferring only 10 per cent of the automotive urban trips of 5 miles or less to bicycles would save the nation 850,000 barrels of oil per day, i.e., about 5 per cent of our total current oil consumption. In Caracas, Singapore, and many other cities, sidewalks have been progressively narrowed or eliminated to make way for wider roads. The comparative absence of crosswalks in Teheran makes pedestrian travel there extremely dangerous.[73/] This would certainly seem to imply that the facilitation of bicycle transport would be of comparable benefit to Third World nations, where public acceptance of bicycling as a means of adult mobility is already high. Yet, even more than in the U.S.,

in the Third World the potential for adapting traffic to the needs of the cyclist through bike-paths or lanes has been ignored by planners.

The deficiencies of public transport--primarily bus systems--are of three kinds: inadequate capacity, lags in the extension of services to areas of urban growth and chronic vehicle breakdowns.

Inadequate numbers of buses mean long waits--up to an hour and more at busy locations--and overcrowding. Often vehicles are burdened with two or three times the passenger loads they were designed for. Though in the short run this kind of "specifications abuse" may result in energy savings, these are more than outweighed in the long term by the likelihood of in-service breakdowns and shortened vehicle lives. The World Bank estimates that as much as a third or more of developing country municipal bus fleets are typically immobilized for repairs. This is generally due to factors such as overuse and overcrowding infrequent or inept servicing of vehicles, poor road conditions, and the overall deteriorative effect of driving in congested and erratic traffic.

The failure of municipal authorities to extend passenger service to new outlying residential areas--and especially to shantytown districts and satellite towns--may prevent these districts from effectively participating in the city's formal economic life, and possibly preventing a better integration of formal and informal sector activities. This simply contributes to the marked division of the city into rich and poor areas which most governments' say they are against.

Transport of commercial freight into, and between Third World cities is an area almost as neglected by researchers as it is important in the scheme of urban transportation. There is simply very little in the way of data on the proportional use of various transport modes for freight transfer, the cost of transport of different classes of goods, and the energy and economic cost comparison of different transport modes for short and long distance transport.

Nevertheless, the point can be made that within Third World cities, the range of freight as well as passenger transport modes in use is much wider than in developed countries. Much intra-urban freight, for example, is carried on animal and human backs or on a wide variety of animal and human-powered vechicles. Operating in the same crowded streets alongside these traditional modes of transport and beyond the city limits are the full array of modern transport devices familiar to the developed countries. Table 12 gives some idea of the broad range of levels of energy-efficiency involved in modern inter-urban freight transportation.

Though compartive data between developed and developing countries are not available to us, it is clear that national uses of these transport types vary considerably with a large number of factors. It is safe to say, perhaps, that for most countries without pre-existing major rail systems, large diesel-powered trucks are increasingly relied on to bear the bulk of inter-urban freight. India, with its colonial inheritance of an extraordinarily comprehensive network of rail linkages and its vast deposits of coal, is an example of the potential for energy--and balance of payments--conserving inter-urban transport but one which few developing nations can afford to emulate. While rail transport is clearly more efficient then road transport, the enormous capital costs and long lead times of constructing a comprehensive rail system tend to make it impractical for many countries. Nonetheless, rail systems have played and will continue to play a considerable--if proportionally diminishing--role in Third World transport.

Table 12

Relative Energy Efficiencies of Various Freight Transport Modes

Transport type	Cargo ton-miles per gallon
one-half of a Boeing 707 (160 tons, 30,000 hp)	8.3
one-fourth of a Boeing 747 (360 tons, 60,000 hp)	11.4
sixty 250-hp, 40-ton trucks	50.0
fast 3000-ton, 40-car freight train	97.0
three 5000-ton, 100-car freight	250.0
inland barge tow, 60,000 gross tons	220.0

Source: R.A. Rice, "System Energy as a Factor in Considering Future Transportation," ASME Paper 70-WA/ENER-8, 1970 in Penner and Icerman, Energy, Vol. 1, Demands, Resources, Impact, Technology, and Policy (Reading, Mass. 1974, p.). Conversions are: 1 foot=.305 m; 1 mile=1.609 km; 1 hp=746 watts; 1 knot=1.85 km/hr. Copyright by the American Association of Mechanical Engineers.

G. Rural-Urban Linkages

1. Introduction

The role which natural resources play in sustaining human existence has become increasingly obscure in a rapidly urbanizing world. Vegetation, still the major provider of food, shelter, and fuel for the majority of humans, is today a neglected resource in most urban areas. For many, it is easier to go to a local supermarket or food stall to purchase vegetables and other necessities than to attempt to grow them one's self. Trade networks between global capitals, facilitated by modern technology and vast expenditures of energy to transport products, allow for mahogany grown in Brazil to become furniture in Hong Kong which is then sold in San Francisco.

The area immediately surrounding most developed-country cities now supplies only a fraction of the food products and forestry materials utilized by the urban residents. Although this trend is much less advanced in the urban centers of Africa, Asia, and parts of Latin America, the forces of international agricultural trade, declining domestic agriculture productivity, and budgeoning urban populations may accelerate this process in the near future. This will add to the problems of urbanization and energy supplies which have already had a devastating impact on the urban poor and the urban ecosystems upon which they are dependent. Yet, in spite of the need to consider how food and fuel will be provided in Third World cities, little attention has been paid to questions of improving urban self-sufficiency in these two areas, and is the center of this paper, especially energy.

The preceding sections of this chapter, describing how energy is used in the various urban-oriented and national sectors of developing-country economies, have also demonstrated that energy flows are neither discrete and isloated parts of the economy nor is their supply and demand impact distinguishable as between the rural and urban sectors of the economy.

In many countries, it can be argued, there is a mutual dependency between rural and urban economies insofar as energy is concerned. For the purposes of this discussion, there are two important aspects of the rural-urban enegy relationships. First, rural and urban areas closely interact with each other in the provision of and consumption of primary and secondary forms of energy and of labor, an important substitute for energy. This relationship parallels the provision of raw materials, in general, their conversion into final goods and their consumption. Second, the distribution of economic benefits is rarely equal between rural and urban areas and, as a result, has a vital bearing on how the rural and urban sectors develop and upon their energy use.

Urban centers are the primary locus of the production of final goods in the economy. The raw matierals for this production, inlcuding energy, are either imported to the country or supplied by rural areas. In most developing countries, labor is provided by city dwellers, to some extent, but increasingly from recent rural migrants. Capital is almost always supplied by urban or foreign sources. The final goods produced have three markets: a) the modern, urban economy, b) the export market, and c) the rural and urban informal economy which as we have seen are closely linked. This inlcudes energy products as well. Petroleum products like kerosene or diesel fuel almost always flow from urban to rural areas. Large-scale hydroelectric power that often orginates in rural areas, is transported to the primary urban market and then is re-transmitted to rural areas as electricity or as electricity-produced goods (this excludes enclave industries like aluminum smelters which may be located in rural areas but have little relationship to the local economy.)

The relationship of mutual dependency between rural and urban areas is strengthened by a system of backward and forward linkages that is centered around an intermediate level between metropoli and small villages. At each point in the flow of energy, raw materials and labor from large cities to secondary cities to market towns

to villages, there is an opportunity for substitutions in energy forms and kinds of labor and for transformation of materials and labor into intermediate and final goods. The economics of these transformation and substitution activities are only imperfectly understood in many countries and focus only on large, urban centers or small villages, by planners, may be detrimental to understanding the vital role played by these intermediate economic centers. The field of energy especially needs more study of the role of these centers in the national energy supply and demand system, (for example, the role of "rural industries" which are often actually in market towns).

With the exception of a few countries, economic benefits are not equitably distributed. The value added by the urban economy mainly stays in the modern, urban sector (whether foreign or domestic) and is rarely adequately re-invested in the rural areas (except for isolated agro-industries) or distributed in the form of infrastructural services or direct inocme to the rural economy or its laborers.

In fact, the relationship between rural and urban areas in many developing countries has been a relatively exploitative one. Mineral mining, raw material extraction (like timber or cash crops), wood and charcoal supplies, and even the rationalization of agriculture into large-scale urban- and export-oriented production centers have tended to exact a net economic and environmental cost which is disproportionately borne by rural dwellers.

Many of these costs could be avoided through careful national planning and changes in development strategy. First, it is important to recognize the need for developing a productive rural economy with adequate basic services and an efficient intra-rural system of economic linkages (hence the imporance of the role of provincial, market towns.) Second, the creation of a healthy rural economy means planning rural, economic activities that do not damage the ecosystem that rural dwellers are so intimately a part of and one that provides for a sustainable flow of raw materials (an increasing proportion of which must be processed in rural areas to help provide jobs and distribute income more broadly).

The results of not accounting for the economic and environmental costs of exploiting rural areas for the benefit of the urban economy may be to encourage the growing flood of rural refugees to market towns and cities which will strain energy budget further, and lead to the depletion of the human and material resource base of rural areas which is indispensable to the urban economy. In other words, it is possible that ignoring the effects on rural economies and environments of economic and energy development projects and activities that are exclusively urban-oriented may result in a net loss of economic production in rural areas or lead to an increase in the demand for urban energy services (from new consumers) or an increase in total energy consumption (from imported goods and materials and their energy components) that may cancel out the benefits (energy or non-energy) of a proposed project. By the same token, to design rural energy and economic development projects without examining what will be the impact of urban-rural linkages on these projects may lead to failure or distortion of the project.

This section will examine what is known of the direct energy-realted rural-urban linkages in order to demonstrate the need for more and better planning of the national energy system.

2. Urban Forestry and Fuelwood Production

Perhaps the single most evident rural-urban energy link can be found in the provision of wood and charcoal fuels for the city. It is a complex and dynamic system that has direct and indirect effects on employment in urban and rural areas, agricultural productivity and food supply, environmental deterioration, the quality of life in urban and rural areas, and impacts on demand for other energy supplies. The first energy linkage has to do with the effect of urbanization on the ability of the city to provide for as much of its own food and fuel needs as it can.

With the exception of China where municipal self-sufficiency in food production is an official policy, food and fibre availability in Third World cities is

dependent upon agricultural and forestry production which is occurring well beyond urban boundaries. Recent trends which are affecting the levels of production in these sectors have immediate significance for the growing urban population in the developing world. These trends, and their impact on health and energy use in urban areas, are portentous.

A decline in urban fringe agricultural and forest land. While data is scarce, it appears that urbanization has caused a considerable loss of farm and forest land on the peripheries of many Third World cities. In Taipei, Taiwan, for example, the urban fringe is used to supply 70 per cent of the total vegetables for the city. The loss of agricultural holdings on the fringe, however, has reduced this amount to 30 per cent, the remainder of the vegetable supplies now coming from central and southern Taiwan.[74/]

The situation in Ibadan, Nigeria, is similar. Extensive urban encroachment on the nearby flood plains has substantially reduced the area planted with traditional dry season vegetables. Further encroachment has also decimated the tree-crop farms. The loss of these areas is even more significant in view of the fact that by 1965, Ibadan was already dependent upon imported foodstuffs to feed its population.[75/] The increased demand for fuelwood resulting from population growth has taken a further toll on the urban periphery. In 1977, a three kilometer zone on the eastern side of the city showed noticeable evidence of deforestation and pollarding.[76/] The vicinity of Ouagodougoua, Upper Volta has been completely deforested up to 70 kms. out from the city. Many other Third World cities are suffering from the loss of nearby agricultural and/or forest land, ranging from Mexico City to Katmandu, Nepal.

An increase in the Use of Energy. The need to go out well beyond cities including imports, to bring in more food for urban consumption is having a substantial impact on the total energy input necessary to bring food to the table in Third World cities. Moreover, a switch to energy-intensive methods of production in some developing countries is resulting in a phenomenal increase in the cost of producing food.

Meier (1978) estimates that food may now directly or indirectly account for as much as half of the energy expenditures in Third World cities.[77/]

One of the few studies of energy flows in an urban food system was carried out in Hong Kong. Newcombe (1977) found that the introduction of energy-intensive agricultural practices had caused the energy cost of growing Brassica spp. (cabbage, broccoli, cauliflower, etc.), the major crop of Hong Kong agriculture, to rise by 585 per cent in a 15-year period from 1961-1976. The concomitant increase in yield was only 8 per cent. He demonstrates that most, if not all of the new energy-intensive methods of production in Hong Kong (such as burning weeds with flame throwers) are superfluous, do not increase yield, and could be dispensed with.[78/]

Newcombe's study of energy use in the Hong Kong food system points to the high energy costs of transportation in farm production even though distances between Hong Kong's agricultural zones and urban centres are small. About 90 per cent of the energy is used to import fertilizers and insecticides from around the world to Hong Kong. In a 14-year period, the application of fertilizers at least trebled and that of natural fertilizers declined to negligile proportions. Aside from the energy costs involved, the previous system of nutrient recycling in Hong Kong in which the nightsoil, animal manure, and compost were all essential features, has been almost entirely destroyed. These formerly useful nutrients are now viewed as "pollutants" and the cost of cleaning them up will be extremely high. Other major contributors to increased energy costs in farm production are intensive irrigation with sprinkler systems, mechanical cultivators, and other machinery.

Energy use in post-farm production in Hong Kong has also increased notably in recent years. The major energy costs are incurred in food processing, packaging, transportation, commercial and domestic cooking, and refrigeration. Of these, transportation and packaging are the most energy-intensive.

The energy implications of rapid urbanization and rising woodfuels demand have not been sufficiently studied for urban areas, but it is clear that deforestation around many cities has caused the urban poor to spend a greater proportion of family income on woodfuel.[79/] People with higher incomes have begun to use commercial fuels such as kerosene where possible. However, since commercial fuels are non-renewable and will eventually be beyond the price range of all but the most wealthy in Third World cities, this trend is not sustainable over the long term, even if the commercial fuels are more energy efficient.

The role of charcoal use in developing countries is a clear case of the energy interdependency of rural and urban area. Charcoal because it is cleaner, more convenient to use, and cheaper to transport is the preferred fuel in urban areas. Unfortunately, the convetional method of charcoal conversion used throughout the developing world is extremely inefficient. Rural dwellers, in the few studies that have been done of their fuel use, are generally fairly conservative users of biomass fuels. Many use a mixture of small branches, seasonal crop residues, and cow dung. On the other hand, charcoal is usually made from felled trees and larger tree limbs. It may well be, then, that rapid urbanization is putting much more stress on rural forests than rural household and industry consumption. As urbanization increases, the demand for wood may be rising by more than the number of new urban consumers, since inefficiently made charcoal will be the preferred fuel.

While the expanding charcoal market may lead to new rural charcoal industry, this employment benefit may be negated by the resulting extensive deforestation which contributes to destruction of watersheds, erosion, and flooding. In addition, the loss of trees means even greater rural use of corp residues and dung as fuels instead for fodder and fertilizer.

Finally, increasing scarcity of rural wood supplies and the presence of an urban market means that woodfuels are becoming more commercialized. With greater purchasing power, the edge in the market usually goes towards the urban consumer, penalizing the rural dweller even further.

The Interrelation of Food and Fuel in Urban Areas

Analyses of the urban wood fuel problem have neglected the combined effect of increasing food and fuel costs for the urban poor. The poor must either cut back on fuel (and hence on warm meals), reduce food intake, or both. Either way, they lose out on effective nutrition. In some cities, possibly many, cutbacks are an evident pattern.[80/] While many governments subsidize fuel costs, this practice will soon become infeasible as the amount of woodfuel continues to decline.

Efforts to maximize the production of fuelwood in urban areas must begin with a recognition of the existing levels and methods of production. Unfortunately, data on urban forestry production in developing countries is not generally available, nor is other important information such as land availability in and around urban centers, land tenure patterns, and growth in urban fuel demand. This lack of data reflects the fact that most countries still do not take urban forestry reduction seriously. Those that do, such as China and Singapore, have very thorough statistics on the formal sector of production, i.e., tree crops produced for commercial sale. However, no aggregated data exist on levels of production in the informal sector (home production used largely for personal consumption).

Fuelwood and tree crop production in home gardens on the urban fringe are two components of urban forestry. Urban forestry is the management science dealing with the manipulation of trees, shrubs, and supportive vegetation in and near cities. An extension of this definition carries us further into the countryside, since we are also concerned with the urbanite's economic, politicial, and physical influence on the landscape at some distance from cities.[81/]

Urban forestry in the Third World has ben yet developed as a discipline in most areas. For some city officials, urban trees and parks mean little more than aesthetic amenities to improve the visual appearance of a city. The value of trees in terms of their food production potential as well as their role in energy conservation for urban areas, has been especially underrated.

To illustrate, many fruit and nut trees provide higher yields per hecatare than traditional agricultural crops, and are excellent sources of nutrition as well. In limited space, the advantages of a tree in providing nutrients and other by-products for use by humans and their livestock, can outweigh the comparative nutritional advantages of cereal grains. A single carob tree, for example, can produce one ton of seed. Irrigated groves in Israel have produced twelve tons per hectare. In food value, carob pods are almost equal to many cereal grains.[82/] Carob pods can be eaten by livestock and ground for use in human food. In addition, carob trees are beautiful and effective shade trees.

Another valuable urban plant is the banana, a common sight in many tropical cities. the Valery variety of banana can produce 72,000 kilograms per hectare of fruit (Lizenberger 1974) as comapred to world averages of 1,664 kg/ha of wheat, 2,466 kg/ha of rice, 2,952 kg/ha of maize, and even 13,986 kg/ha of Irish Potatoes.[83/] The edible portion of banana is about 75 per cent water, 1.2 grams of protein, 0.2 per cent fat, 23 per cent carbohydrate, and 0.1 per cent ash. Thus, bananas are an important energy food, but most importantly are a craotene--rich fruit and provide an inexpensive source of Vitamin A. Finally, banana plants serve many purposes in the tropics in addition to being a staple in the diet. The trunk is often chopped up and fed to pigs. The trunk sheaths are doubled over and used as planting containers in tree nurseries. The xylem strands are twisted together and used as ropes. And a banana leaf can be cut up and made ito small pots for transplanting garden seedlings and can serve as a cooking wrapper.[84/]

Table 13

Energy Use in The Food System of Hong Kong

Item	1950s	1971
	Energy Inputs (GJ/ha)	
Insecticides	3.34	4.43
Fertilizer	13.68	136.65 (mostly artificial)
Human Labor	44.05 (15 full-time)	8.81 (3 full-time)
Machinery	-----	------
Irrigation	6.04	114.29
Admin., research, and extension	2.51	2.51
Hand tools	.12	.12
Seeds	.23	.23
Transportation	9.43	9.43
Total input	72.77	426.06
Gross Yield	89.72	96.52
Net yield	89.49	96.29
Ratio of Energy Input to Output	1:1.23	1:0.23

Source: Newcombe 1976.

Efforts to Improve Conditions. Below we describe briefly some examples of efforts to reverse the trends desribed above.

(1) China

China's urban reforestation effort since the end of World War II is a monumental achievement. Every major city, most of which were completely denuded at the end of the war, now look like green canopies from the air. Nanking, for example, has planted 29 million trees in the last 20 years.[85/] Major routes to and from the urban centres are lined with as many as five rows of trees and frequently as many species. Most of these trees are slated for eventual harvest and use as wood products; the remaining trees serve as windbreaks and for shade control. Suburban communes are also surrounded by windbreaks and rows of plantings for erosion control.

Trees within the city centres have been primarily used for shade control. Hundreds of thousands of London Plane trees line the streets in Shanghai, for example, providing a cool and pleasant environment for pedestrians in the hot summer.

Since many of the trees in China's urban areas were planted at the same time and are now maturing simultaneously, harvesting of the trees on a rotation basis has been initiated. To facilitate rotation, the Peking Park Department has five nurseries with over one and a half million trees at different stages of growth ready for transplanting in the capital.

China's urban forestry goals are still more extensive for the future. A goal of planting one million trees a year in eight major cities has been set for the next six years until 1985. Nanking is attempting to plant over five million hectares which will be called the Green Great Wall. The greenbelt will act as a shelter belt and prevent erosion.[86/]

(2) Bangalore, India[87/]

Bangalore is located in the tropics with a population of 4,000,000. The city is one of the few in the Third World to have an official urban forestry program

with a variety of components: street tree and urban park management, fuelwood and production forestry systems, industrial forest demonstrations, and national park and forest programmes. Interestingly, twenty three per cent of Bangalore's total municipal tree population is fruit trees, which also provide shade and ornamentation. The most common species are mango, jackfruit, guava, papaya, and sapota. Experiments in agroforestry, for example, interplanting an agricultural crop such as castor bean between rows of sandlewood trees, are also being practiced in the peripheral areas of the city.

Fuelwood plantations have been established in the greenbelt surrounding Bangalore and in the immediately adjacent countryside. Varieties of eucalpytus, including the Mysore gum, and native trees are under test. The importance of parks in providing recreation for city residents has also been recognized. Bannerghata National Park is only 24 kilometers from the city centre and provides 100 square kilometers of native forest and wildlife for the enjoyment of Bangalore's residents. Interurban buses make the park readily accessible.[88/]

(3) Addis Ababa, Ethiopia

Addis Ababa provides one of the most striking examples of the value of urban forestry and the potential for supplying urban wood fuel needs. Ethiopia has suffered massive deforestation since before the 16th century. After Addis Ababa was founded in 1890, a twenty kilometer area around it was rapidly stripped of the few remaining trees. As a last effort prior to moving the capital, *Eucalyptus* was introduced. At least 15 eucalpytus species were brought into Ethiopia, but *E. globulus* was the most extensively cultivated. The others failed because their cultivation required too much care. Special tax benefits were given to land owners to encourage them to plant trees.

By 1920, the city had been fairly densely planted with trees. The forest continued to spread. By 1957, it reportedly covered 175 square kilometers (100 square

kilometers actually covered by trees) and by 1964, the forest had expanded to 250 square kilometers (135 sq. km actually covered by trees). Thus, in the intervening years, there has been an increase of almost 5 square kilometers per annum.

Eucalyptus wood is now used for a multitude of purposes in Addis Ababa. Eucalyptus lumber supports over 90 per cent of the structures of the city. The wood is used for fuel and building materials. Much of the cooking in the city is done with the wood and leaves. Some even consider eucalyptus leaves absolutely essential to make good quality "enjera", the unleavened bread that is a traditional Ethiopian staple. It is also used for tool handles, furniture, telegraph and telephone poles, and fences among many other uses (Hovath (1968) and Poulsen (1978) as adapted in National Academy of Science, forthcoming firewood study).

(4) Urban Trees and Energy Conservation

The role of urban trees in energy conservation can be equally impressive. Research in North America and Europe has shown that greenbelts can significantly reduce the adjacent city temperatures compared with those in the center of the city. Dense shade from trees has also been found to reduce the air-conditioning costs of homes in the Southern United States by a substantial amount. Trees themselves act as air conditioners: a single isolated mature tree with adequate water transpires 100 gallons of water per day, providing the cooling equivalent of nine average room air conditioners operating at 8,000 BTU/hour running 12 hours per day.

Consequently, especially in hot climates, properly placed vegetation can play an important role in reducing temperatures within homes and office buildings and on the streets where many people spend a major portion of the day in Third World cities.

Other Rural-Urban Linkages

Much of the discussion of linkages in this section has concentrated on food and woodfuels for urban areas. This is perhaps the most important set of rural-urban linkages, but not the only one. In this chapter, the sectoral discussions indicated several other important areas of linkages that need further examination and consideration in national energy planning.

a. Modern Rural-Urban Linkages. A wide-ranging set of activities, most of them concerned with transport of materials and people help to integrate the modern economy, including rural areas. These include manufacturing, mining, agro-industries, and transportation (inter-urban road and rail transport, canals, air transport, pipelines, and long-distance electricity transmission.) For the rural dweller, the activities with the widest-ranging impact are in the transport of goods, people, and services (especially electricity.) These permit the wide marketing of goods and acess to urban-produced manufactures as well as access to urban employment and educational opportunities. In most countries, the operation of transport services is dependent upon a steady supply of oil. For oil-importing countries, in particular, this fact means that creation of a modern-integrated economy will continue to be difficult and uncertain as long as the international oil market remains unstable.

Industrial demand for woodfuels from rural areas can be expected to grow in many countries where oil and electricity supplies remain either more expensive or unavailable. In large-scale industries, charcoal for smelting purposes and crop wastes from on-site power and process heat for agro-industries will be the most important applications. The growing use of bioalcohols for industry and transport poses a number of potnetial problems for some countries concerning the alternative uses of land for food or fuel.

Small industries are likely to continue using traditional fuels especially charcoal for direct heat purposes. Examples inlcude brick-making, pottery, cement,

glass-making, beer-brewing, and baking. The impact on the local environment, particularly around market towns, of traditional fuels use in small industry needs to be studies further.

b. Informal Sector Services. Some of the energy-using activities within this sector may contribute net benefits to rural dwellers, others may not. The linkages in this sector are especially strong and it is an area whose energy impacts need much more study.

(1) Subsistence food-growing and urban food production (for local markets) around the cities, especially where the farmer works part of the year in the city or markets his production in the city.

(2) Making, transporting, and selling charcoal from rural areas to cities. Evidence suggests that these operators (especially the trnsport middlemen) are urban dwellers. Are rural dwellers hurt by the diversion of woodfuels to cities?

(3) The production of stoves and other cheap, intermediate technology goods for the poor, urban market, and the rural market. Do these products help to save energy in rural areas?

(4) Provision of a labor pool from rural areas for low and semi-skilled work in the cities that is energy-substitution. Does the incremental energy demand of these people for urban energy negate their value as energy substitutes?

Energy pricing importantly affects rural-urban linkages. For example, if there is a national kerosene subsidy, (for the purpose of ensuring political-usually urban-stability), will urban consumption remain at a higher than desirable level (from the point of view of oil imports and the budgetary burden of the subsidy) or continue to grow? And if only a certain level of oil imports can be maintained will this mean a diversion of available supplies to the cities, leaving the rural market dependent on scarce woodfuels or other traditional fuels?

Should electricity prices be set so as to encourage small industries in rural areas, large industries in urban areas, or widespread household consumption to substitute for the scarcity of other fuels?

Clearly, many of the rural-urban linkages described in this section have important relationships to other sectors of the economy and to a country's development strategy. In Chapter III, we will discuss some of the national planning implications of these relationships.

Chapter III - Energy Problems and Outside Aid

A. The Data Gap Problem

One reason for writing this paper was the need to understand how energy use in developing country urban centers was different from that of the rural areas and whether there were any relationships between the two. The energy activities described in Chapter II indicate that much more energy is used in urban areas for a wider range of activities than is the case with rural areas. However, there are important energy-related links between rural and urban areas too.

A major barrier to devising effective policies to help alleviate energy shortages or make existing supplies go further is the lack of comprehensive energy data in both rural and urban areas on the patterns of use, including efficiences of conversion, appropriate matching of fuel to end-use and the environmental and social costs of certain kinds of energy use patterns.

The lack of good data on energy is not a frivolous concern. It may allow energy problems to worsen. Energy planners in developing countries were largely unaware until recently of the woodfuel-related deforestation going on before their eyes. Even good statistics on the use of energy in industry is lacking in many countries, which makes industrial investment planning much more difficult. Much more serious has been the lack of data on how energy is used by the poor and the costs to society of th e misuse of traditional energy use patterns, of the energy-related relationships between the formal and informal sectors, of the explicit and embodied energy costs associated with alternative designs of commercial buildings, water and sewage systems, and various transportation alternatives.

Given the high and increasing cost of commercial energy and energy-intensive materials, closing the data gap on the use of energy and available alternatives must be a high priority. Otherwise, opportunities for improving existing use of energy

and finding ways of providing more may be lost and an already critical energy situation may turn worse.

This chapter outlines the problems faced by governments with respect to urban energy use overall and in each of seven sectors in urban areas. Whenever possible, deficiencies in the current data base are indicated and possible ways to rectify the situation pointed out. This chapter also gives a range of existing alternatives and policies for action on energy use in urban areas, but it must be stressed that many alternatives and improvements remain hidden simply because of a lack of knowledge of energy use patterns and supply potential.

B. Comprehensive Strategies

1. Introduction.

The pace and direction of urbanization portends a world containing large unacceptably crowded, underserviced, jobless and wretched areas.

Our definition of urban is broad, encompassing primary cities, secondary cities, and larger market towns. However, since most of the acute problems of the urbanizing trends just mentioned occur in larger cities, most of our discussion will deal with those places.

Significant in the process of urbanization is the fact that cities--with all of their misery in prospect for the future--contain the hope of less misery in the present than life in the countryside, a contrast that encourages people in the country to migrate to the cities. This differential is importantly related to the presence in the cities of greater availability of modern fuels than in rural areas to provide higher levels of energy services. The dilemma is that without increased energy services in the cities, conditions will grow less acceptable; yet with more energy services available, the differential between cities and country may widen attracting more people to the cities and continuing the viscious circle. If this is indeed what happens, it is a cruel tradeoff.

Whether government actions could affect the trend toward the cities is even less well known.

In some cases, countries may conclude that there is little use trying to influence city size and national spatial arrangement on the grounds that these matters are the products of economic and cultural forces too deep to be redirected by normal governmental actions. They may conclude that urbanization of their country is as inexorable as it has been for the industrialized countries, and that they must go through a painful period of excessive urbanization following which a reverse migration flow will occur (as seems to be the case in some industrialized countries) leading perhaps to a stable balance. If this traumatic process must continue for perhaps 50 years before it is played out, then there is a strong case for interim actions to make life in the cities (as in the countryside) less miserable, and to improve the health, the longevity and the education of the people. Under this approach, urban layout would be planned to maximize services, reduce congestion, and provide employment while at the same time minimizing the use of expensive energy sources and capital.

Other countries evidently have decided that in their case something can be done to stem and perhaps to reverse the tide of human migration from farms, villages, and market towns to large cities. One finds an official policy to achieve such a goal in such countries as Panama, Peru, Columbia, Indonesia, the Dominican Republic, Tanzania, and Mexico. Under this approach, national planning would emphasize jobs in satellite cities, in smaller cities along a corridor in agroindustries, or in industrial parks. This would call for different energy strategy than a policy of permitting large urban agglomerations to continued unchecked.

Fortunately for the aid agencies of the world, they do not have to make these difficult choices on excessive urbanization and urban design. The choices can

only be made by each country for itself. And because each country is sui generis, each solution must be tailor made for that country.

This does not mean that aid agencies have no role in the decision. It does mean that their role is not to seek a universal answer to the question of optimium city size, urban hierarchy, urban design, or migration policy since there can be no solution universally applicable to such diverse situations. Rather their role is that of facilitating the efforts of Third World countries that alone can make such deeply sensitive, intimate, and important decisions. In countries where these issues are already pressing for decision, aid agencies can help by financing studies that produce facts needed to assess the problems and analyses that will clarify the issues. In the process of conducting such country specific studies, aid agency officials may develop a strong conviction as to which choice is wisest for that country. Some aid agencies at that point may insist that the host country accept their views as a condition of any financial aid. Others may express their views but not insist on them. Still others may present facts and contending analyses, diagnoses, and prescriptions, but refrain from expressing a viewpoint. Aid officials should painstakingly think through what role is aappropriate for themselves. Many of them have not lived in the particular country long enough to have gained enough understanding to responsibly make such a decision. Nor do they have to live with the consequences of the decision. Participating in or financing a single study does not earn one the right to have his views weigh as much as those of knowledgeable country nationals and certainly not to insist that his views outweigh the views of country officials. The vigor with which an outsider presses his views on such sensitive matters should bear a close relationship to what he has earned by exposure to the problem.

In some countries, there may not be much awareness of the difficult decisions that will need to be made. Aid agencies can help to create such awareness, for

example, by sponsoring studies--especially by local scholars--of the issues and encouraging them to publish the results of these studies thus initiating the kind of scholarly debate that can promote awareness of issues among public officials.

2. Excessive Urbanization and Energy Strategies

Each country, as we noted above, must decide whether to resist excessive urbanization or to take steps to make it more tolerable. The link between that choice and the country's energy strategy is complex. The choice of urban strategy will affect the amount, form, source, and location of energy needed. A decision to resist the urbanizing trend may generate decisions to neglect the city, to encourage jobs in satellite towns, market towns, and industrial parks, and to bring amenities (requiring energy services like heat and light) to farms, villages, and market towns. This development strategy calls for a relatively more decentralized energy strategy, for example, depending less on an electrical grid and more on decentralized generation of electricity and on the use of local energy sources including renewable ones. With the exception of large hydroelectric generators, some geothermal sites and large tree plantations, renewable sources are inherently decentralized. Conversely, a decision to try to improve the quality of urban life might lead to policies that promote jobs, education, health services, and urban utilities in the large cities all of which might make centralized sources of energy more attractive.

But the choice of an urban strategy does not depend greatly upon the availability of a suitable energy regime. An energy regime currently dependent on centralized oil, coal, hydro, or nuclear can be adapted to meet the energy needs of a decentralized urban development strategy. To be sure, it may cost more to deliver energy from conventional sources (oil, gas, coal, and electricity) to farms, villages, and market towns than to large cities, but it can be done and

as renewables substitute for these conventional centralized sources, it may actually become cheaper to deliver energy services in rural areas. In other words, choice of urban development strategy governs the choice of energy strategy but the reverse is not true.

Aid agencies can help developing countries develop information on which to base a sound choice of urban strategies. Basically, the decision whether to resist urbanization turns largely on the question whether any governmental actions are likely to have an affect on rural to urban migration and on urban birth rates. Aid agencies can certainly shed a great deal of light on these questions by financing the right kinds of studies. However, these matters fall outide the purview of this paper which deals only with urban energy.

3. Resource Conserving Urban Design

There are two cross-cutting issues confronting developing countries. First, is the issue of whether to make cities more attractive which risks the acceleration of rural urban migration; that is the issue discussed above. The second issue is whether to deliberately plan the construction of buildings, roads, and services, and the location of homes in relation to jobs, shopping, schools, and other services within the cities to minimize the cost of providing energy servies. Urban congestion forces people to live on the outskirts of the city often commuting to a job in the center. In the absence of powerful forces to reverse the trends, the Third World cities of the future will be as sprawled as Los Angeles, presenting a commuting problem whose solution may be energy wasteful. Services (streets, lights, sanitation, water, transportation, fuel, health, eduction, etc.) may be left to evolve in ways that waste energy and fail to serve effectively or they may be planned according to a configuration that maximizes energy productivity. Industries, commercial buildings, and residences may be designed and operated in traditional ways that increase the cost of the energy services required or they may take

advantage of design, siting, and other technologies that can substantially reduce the costs of those energy services.

This second choice, in brief, is whether governments should take steps to ensure that the location and construction of homes, businesses, industries, streets, utilities, and transportation systems maximize energy productivity. Indeed, would it do them any good to be concerned about the problem, or is it too expensive to consider? Certainly, if it were a matter of tearing down existing structures and infrastructures and replacing them just to improve energy efficiency, the economics would be doubtful. But, in point of fact, the pace of construction in Third World cities is so astonishingly rapid, that most of the structures that will be in existence in the Third World cities of the year 2000 have yet to be built. This makes it practical to consider an energy efficiency program. But we do not yet know enough about costs, methods, and potential return to advise any given Third World government to embark upon such a program. Indeed, there is reason for caution. The DOE/State energy assessment on Egypt concluded that increased energy efficiency in that country could only save 4 per cent of the energy (electricity) used.[1/] This was a macro assessment which left a number of potential savings out of account. Only a detailed survey by teams that visited factories, inspected commercial buildings, evaluated the transport systems, and sampled household practices could judge whether the 4 per cent figure is reasonable. But, meanwhile, we must caution against aid agencies proclaiming conservation as a panacea. From the points of view of an enterpreneur, an industry or a nation, there is nothing inherently superior about saving energy over producing more energy and from those points of view, programs that have as their sole objective saving energy are not particularly useful. (Conversely, one can make a good case for conservation of oil, other depletable fuels, and raw materials from the point of view of the entire world). Should the potential of conservation

for the Third World be as low as 4 per cent (which would be astonishing and disappointing) it might not be worth a major investment.

There is a widespread (and altogether accurate) perception in the South that the industrialized countries are the world's great wasters of energy, and that, by comparison, Third World energy waste is only a drop in the bucket. There is, in particular, a great deal of resentment at the Northern waste of oil, a globally depleting resource. We have found that it impedes communication to talk of conservation in the Third World. When we change the semantics to "improving energy efficiency" communication is improved with some people but with other Third World energy analysts, the change in terms does not help; there is a lingering question why the Third World should struggle to conserve its drop when the North goes on spilling its bucket. One expert from Mexico argued with us that wasting energy had been historically very useful for the North because it had made possible a fruitful learning process through trail and error--an experience that should not be denied the South. An expert from Senegal said that the poorest Senegalese aspires one day to drive a car and it would not be fair to push upon the South a conserving ethic that would dampen this hope. These are strong feelings that must be dealt with. There is a good chance to do so because the logic of energy efficiency is even more powerful for the Third World than for the industrialized countries: First, nobody can afford to waste energy--and the more expensive it becomes and the poorer a country is, the less it can afford energy waste. Second, energy efficiency in the South does not mean giving up pleasant activities or doing without; it means using energy more productively. In some case, it means cutting down unpleasant activities (e.g., sitting in traffic jams or suffering long commutations). Third, because the developing countries are building new economic infrastructure at a rapid pace, attention to energy efficiency can make a difference in their total energy bill sooner rather than later.

The problem is how to make these points to people who suspect the message is motivated by a Northern desire to hold oil consumption down in the South so that the North will have more. We believe the self interest of each developing country is so clear that notwithstanding the impediments to communication, the message, if repeated often enough--in particular by Southern scholars and especially by examples of particular efficiency gains that can be made in particular localities, factories, suburbs, or building practices--will become accepted by energy policymakers in the South. Of course it is obvious in this context that a vigorous conservation campaign in the North--and especially in the United States--would do much to allay Southern suspicions of Northern motives.

Recently, a new framework for analyzing energy use has appeared in the U.S. that may successfully reconcile the dilemma between increasing supply and conservation. It is called "The Least-Cost Energy Strategy."[2/] Written as a frame of reference for making energy investment decisions for the United States, this concept, when applied to the Third World can provide a useful format for advocating energy conservation in that part of the world which uses the least amount of commercial fuels. The idea of a least cost investment strategy--whether for energy or any other purpose--is, of course, not new. Rather it is a specific and timely application of an investment criterion long since tested and proven. Nor do we wish to imply that the chief reason for applying it is to extricate ourselves from the dilemma created by Southern sensitivity to Northerners preaching conservation. Indeed, the least cost energy approach should be applied by Third World investors because it makes sense in and of itself.

In brief, the least cost strategy asks what energy service is needed and then seeks the cheapest way to get that service. Energy service needs to be distinguished from fuels. For example, a home owner does not need a given number of cubic feet of gas per year (i.e., fuel). Instead, his need is for 8000 cubic feet of space kept

at 68 degrees in the winter and at 75 degrees in the summer (i.e., energy service). The goal may be pursued with an electric or gas heat pump, with proper siting and shading, with passive or active solar energy, with insulation, with automatic heat and cooling controls, or with a careful mix of more than one of these and others. But notice that conservation practices and equipment are not distinguished from those technologies that supply energy. There is complete indifference between whether a service is provided with oil, solar, or more insulation. No particular source is advocated or discouraged. In this model, conservation technologies must compete with supply technologies in order to win a place. Conservation or renewables are not given status as morally superior ways of achieving a comfortable room. A "source" is superior only if it does the job at less cost than alternatives. Treating conservation in this way should eliminate the tendency on the part of Third World persons to oppose it. In fact, the issue would not even arise since conservation technologies are submerged in the least cost strategy as several possibilities among the range of alternative ways of achieving an energy service. The idea is to look at all the options and then seek a strategy that minimizes the cost of the energy service.

But what assurance is there the least cost strategy will achieve environmental and energy security objectives? There appears to be a fortunate serendipity about the least cost approach at least in the preliminary calculations applied to the U.S. by its authors.[3/] Not only does it minimize cost, but also it seems to reduce oil and coal consumption as a precent of total energy use and to reduce total energy consumption as well. The demand for centrally generated electricity declines under the least cost model which may reduce the need for nuclear generators. Thus, in addition to cutting costs, it seems to conserve oil and to reduce those energy sources (coal and nuclear) that most seriously threaten to damage the environment and to encourage proliferation of nuclear weapons.

The least cost model will work best where energy prices and volumes are determined by a market where all potential suppliers of energy services can compete freely. For example, if the price of natural gas is held artificially low by government action, then the least cost calculation will be distorted and tend to favor gas as opposed to solar, oil, or a furnance heat recuperator.

More work is needed on this model before it will be known how well it might apply to the non-OPEC Third World. Aid agencies might want to consider supporting a case study that applies it to one or more Third World countries especially concerning its ability to deal with non-market objectives and costs. Even if a developing country had a relatively competitive market situation, market price signals might not adequately reflect the social desirability of reducing woodfuel consumption until deforestation had already resulted in actual wood shortages which might not be until ten years after forest reserves had begun being "mined" (in the sense that annual wood harvests exceed annual wood growth). By that time, much damage might have been done to soils and underground water levels. Such externalities would need to be factored into the calculation of costs. It is, of course, not easy to put a monetary price on the value to a country of conserving fuelwood. The theory of doing so is well established but lacking good data on the extent of deforestation, and the damage it does through lowered water tables and soil erosion, it would take some experience to be able to do a reliable job of assigning a cost to such externalities. Thus, for the time being, until that experience has been gained, we are not suggesting the least cost method as an established science but rather as a mental attitude for investors and policymakers.

Meanwhile, it would appear advisable to avoid pushing the idea of energy conservation with any given Third World country since from that country's point of view, there is no valid reason for advocating a particular technology unless it provides energy services at minimum costs. Instead, communication should be in

terms of providing current and future energy services at least cost, analyzing all opportunities for doing so including those typically considered conservation in nature.

A Role for Aid in Achieving an Energy Efficient Urban Design

A few words may be useful on what aid agencies can do to help countries with their overall probelms of urban design. We distinguish between two situations; first, where a country is not convinced that it is important to plan for an energy efficient urban design and second, where a country is already aware of these matters and is eager to have help.

In the first situation, there are several kinds of activities donors can take to enrich the awareness of host country officials of the problem. We illustrate with three examples.

1. Grants to local scholars to study any of the many aspects of urban design from the point of view of energy productivity and grants to ensure that deserving studies are published or reproduced and widely disseminated. The topics of such studies might include gathering data on the current use of energy in specific industries and the potential for saving through improvements in plant buildings, in industrial processes, in plant layout, and in energy saving equipment. Studies might be made of typical energy use in residence and opportunities to minimize the cost of the energy services required. Studies of energy productivity in the transportation system would be valuable. Studies of urban waste disposal and the opportunities to lower energy service costs by recycling such wastes might also help.

2. A professional journal on energy productivity in the Third World might be a useful companion piece to the studies. The journal could summarize or adapt articles from such studies as well as from voluntary offerings or commissioned pieces. The journal would be a key vehicle for disseminating ideas and information on

energy productivity among scholars, engineers, contractors, architects, and relevant government officials throughout the Third World. Eventually, it might become at least partly self supporting. As an alternative to starting a new journal with all of the complexities inherent in such a course of action, existing journals might be examined to see whether they would be amenable to featuring materials on energy productivity in the developing countries. Other techniques for public education on the topic might include 1) a service that digests and disseminates energy productivity information, 2) providing subscriptions of relevant journals to LDC libraries, 3) workshops at the regional or stbregional level on energy efficiency and the like.

3. Offer to send a survey team of outside experts to assess the possibilities to improved efficiency through improving the basic design of a city or of the urban hierarchy in an entire country.

Turning to the second situation where a developing country is eager for help with energy productivity, we offer the following illustrations of activities for aid agencies:

(1) Help the government to establish an energy efficiency unit, located within the relevant ministry or in a university or para-statal organization. This unit might gather information on wasteful energy practices and on ways of improving efficiency and make that information available to relevant ministries and persons on construction standards, zoning plans, street layout, urban utilities, transportation plans, energy pricing, industrial permits, and other subjects that importantly involve energy efficiency.

(2) Help establish a program to train energy auditors either in governemtn or in the private sector. These auditors would be available to managers of factories, commercial or government buildings, transportation facilities and, in some cases, to individual residents to advise on ways of providing energy services at lower costs.

(3) Training, Survey Teams, and financial support are discussed under Chapter IV.

C. Aid Activities by Source of Energy

We turn now to the sources of energy, briefly discussing the kinds of aid activities that might be relevant to each.

Although most sources of energy supply are available for use in the rural as well as the urban sector, nevertheless any conventional large-scale energy source that takes the form of electricity or fossil fuels is destined to be used overwhelmingly in urban areas. Likewise, small-scale renewable energy technologies can be given selective applications in the cities. Hence, we discuss them briefly below. To be exhaustive we could have discussed how to help oil importing developing countries pay for their oil imports. However, this is not typically a kind of aid given by foreign assistance agencies and in any event the topic is so complex as to be beyond the scope of this paper.

1. Oil, Coal, and Gas

The Third World is extremely dependent on foreigners to help find and produce local fossil fuels. Overwhelmingly, the foreign input is through the private sector. But there is a role for aid agencies. We have identified some of the elements of this role elsewhere.[4/] Three kinds of activities are suggested here:

(a) Training

Almost without exception the people we talk with emphasize the importance of training people in the Third World to understand and deal with problems of oil, gas and coal exploration, production, and use. Aid agencies would be well advised to devote resources to this activity.

(b) Surveys

Aid agencies could carry out geological and geophysical surveys to give a preliminary indication of whether such resources are available.

(c) Encourage Private Enterprise

Most oil, gas, and coal discovery and production is done by private enterprise. Aid agencies should help get developing countries and private enterprise together. To some extent, this is being done by agencies such as OPIC and the World Bank. Whether more is needed depends on the results of a debate now going on within the oil community over what is holding up exploration in the non-oil exporting developing countries. Some suggest the problem is that oil companies fear political risk to their investment. Others insist the more important risks are geological and economic. Aid agencies might sponsor a major international study to speed the resolution of this debate.

(d) Direct Assistance Needed for Coal

In the case of coal, it may be necessary, in some cases, for aid agencies to take a more active role because private enterprise may not be as dominant as it is in oil. This may include loans or grants for technical assistance to help a country decide whether to develop a coal mine and, if so, help with a feasibility study that would be needed to obtain aid financing for the project. Aid agencies may also find it appropriate to provide capital assistance. A proposal has been made to the German aid program to support an international coal R&D institution to help developing countries find, develop, and use their coal resources including some new and old applications for decentralized use such as producing acetylene lighting and perhaps cooking from coal and limestone. Other aid agencies might wish to join in support of such an international institute.

2. Hydroelectricity

In some cases, (e.g., see the Maseru case study appended) electricity is used interchangeably with oil, wood, and coal. It fires small industry hot water and steam (e.g., canning, tanning, and candle making in Maseru), and provide space heating and cooking energy. Thus, hydroelectricity may be considered an oil and

wood saver. To the argument that making electricitx loses two-thirds of the original energy resource thus making it too energy inefficient to use electricity in lieu of coal and wood, one African official replied that it is better to lose two-thirds of the hydropower by making electricity than to lose 100 per cent of it by letting the water flow unharnessed to the sea. Of course, that argument only applies where unexploited hydropower is plentiful. One useful service that aid agencies could render would be to assemble information for Third World enterpreneurs and policymakers on all of the possible situations where hydroelectricity (including medium and small-scale resources) might be used to substitute for oil or wood (where it is in short supply).

In the case of large-scale hydroelectric generation, aid agencies may help with site surveys, feasibility studies, training, and capital loans to cover imported equipment and expertise as well as local costs. Capital equipment financing may be supplied not only by aid agencies, but also by export promotion agencies that supply credit (e.g., the U.S. Export Import Bank).

In the case of small-scale or "mini" hydroelectricity, aid agencies may help to finance surveys of small streams in order to discover sites with enough stream flow throughout the year to meet some of the electricity needs of a nearby village. In addition, aid agencies can supply grants or loans to meet the capital costs of such installations. This kind of resource may help with urban energy problems in two ways: first, by reducing the need for conventional rural electrification, saving centralized electricity for the cities, and second, it is conceivable in a few instances that mini hydro production would exceed rural needs and might be exported to nearby market towns and small cities.

3. Nuclear

The earlier enthusiastic U.S. and IAEA programs of helping developing countries make use of nuclear energy have become complicated by the somewhat contrary

goal of helping them develop energy sources that run no risk of proliferating nuclear weapons grade material. For the most part, aid agencies do not become involved in nuclear energy--either in encouraging it or in discouraging it. At the moment, we do not see a role for aid agencies so long as the nuclear industry is not able to resolve its very serious environmental, security, and economic problems. Therefore, nuclear energy appears to hold little promise for developing countries. However, some of the best minds in the world are working on problems that beset the nuclear industry. Should the problems be resolved, we see an important role for aid agencies and others in the development community. The role is to help LDCs make use of the energy resource. Two kinds of activities would be needed: First, the nuclear industry would need to be encouraged to develop nuclear reactors small enough to meet the needs of most LDCs and second, LDCs would need a great deal of special training and technical assistance to help them operate reactors safely and special help in disposing of nuclear wastes. For the present, aid agencies should take no action except to observe the progress of the nuclear industry so that, if that serious problems of the industry should be resolved, aid agencies can move quickly to take the actions suggested above.

4. Solar Energy

Solar energy (including wind) in the Third World is normally regarded as limited to rural areas. There may be some exceptions. For example, a rural solar cooker expert in Ouagadougou expressed the opinion that the first practical uses of solar cookers will be in urban areas perhaps by makers of bread or beer or other users of low to medium grade heat who are very mindful of the increasing costs of charcoal that they use. Elsewhere, we have discussed the methodology for surveying energy needs and testing renewable energy equipment in rural areas of the Third World.[5/] To explore the potential of renewable energy in the urban context, our basic formula would be much the same as for rural applications: Aid agencies can

help in three ways. First, they can help find out what primary energy exists; second, they can test technology and report on what works; and third, they can conduct research on kinds of urban energy needs that might be met with solar energy.

One must concede that very little is known about the potential of renewable energy (other than hydroelectricity) for urban use. In the case of rural applications, various aid agencies have hundreds of tests planned or under way.[6/] The same kind of testing over a multi-year period would be necessary to formulate a judgement on the promise of renewable energy for cities. The critical test will be whether renewable energy can perform energy services as reliably and cheaply as other means. Several technologies probably warrant testing in urban areas including: 1) flat plate and concentrating collectors to heat or preheat water for industries (e.g., breweries, hotels, and canneries) 2) solar ovens for such industries as bakeries, 3) distilling water for batteries, 4) converting sewage to biogas for industrial or residential use, and 5) passive or active solar collective for space heating in hotels, commercial businesses, and offices.

D. Sectoral Level Urban Energy Strategies

1. Energy for Industry

a. Modern Large-Scale Industry

The building of large-scale modern industry is considered synonymous with development itself by many LDC's. Thus, satisfying the energy needs of this sector is of utmost improtance to meet both political and development objectives. Most LDC modern industrial sectors use energy in a fashion similar to the industrialized nations. They have the same need for steam, mechanical drive, process heat and feedstocks because their manufacturing processes and operation systems have been designed in inudstrialized countries. Hence, the U.S., with all its industrial experience should be able to provide quality assistnace.

In many LDC's the industrial sectors are growing rapidly. Those in charge of the industrial sector confront a number of difficult decisions including, in the case of both new and existing industry, choices of technology, of energy source, of plant layout and management, etc. In the paragraphs that follow, we will briefly describe the issues, choices and ideas for aid agencies to be helpful. We will first consider existing industry and then new industry and finally role for government.

Existing Industry

The analytical approach to energy strategy development for in-place industry should begin with the collection of data on energy services currently required by each industry. How much steam is needed? What quantities of direct heat are demanded? Are these requirements high temperature or low temperature in nature? How much mechanical drive or space heat is needed? These are the major energy "services" that industry uses to produce goods. They should not be confused with fuels. Fuels are only one means of supplying these services. Table 14 illustrates

the type of data that would be useful to assess the quantity and kind of energy services demanded by existing industry.

Obviously, each LDC is unique. The table would have to be adjusted for each country depending on the nature of its existing industry and ability to collect end use energy data.

Table 14

Industrial Service Sectors

TYPES OF INDUSTRY (illustrative)	Hot Water & Process Steam (temperature requirements)				Direct Heat (degrees Fahrenheit)				Feed-Stocks	Space Heat	Other	Total
	Hot Water	Up to 57 psig* and 300° F	Above Either 57 psig or 300° F	Sub-total	Below 300°	300°-600°	Above 600°	Sub-total				
STEEL MARKETING												
CHEMICALS												
PAPER MARKETING												
GLASS MFG.												
CEMENT												
AUTOMOBILE ASSEMBLY												
TEXTILE PRODUCTION												

* psig: pounds per square inch gauge pressure

Source: Dennis Bakke

Each energy service needed by an industry can be provided, at least partially, in many different ways. Included may be both conventional (e.g., oil) and unconventional (e.g., wood) fuels. Also available are technologies that help provide the service by reducing the need for fuels such as heat recuperators and steam pipe insulation. For example, meeting the process steam needs of a pulp mill might be accomplished using gas, oil, coal, charcoal, electricity, and/or wood. It can also be met with a cogeneration technique that provides both steam and electricity, or more efficient steam boilers can be added, a condensate return system installed, boiler fuel pre-heating initiated, or vacuum pumps substituted for steam injectors.

Each technology that is a potential contributor to meeting industrial requirements should be analyzed to determine its cost and the share of the energy service it can provide. For example, an existing oil fired boiler may provide 100 per cent of an industry's low temperature/pressure steam at $7.25 per million BTUs. This is one option for providing the service. Another may be the installation of a more efficient boiler which by reducing the fuel used to produce the steam is capable of providing some portion (e.g., 25 per cent) of the steam required at $4.50 per million BTUs. The $4.50 would include the amortized capital cost of purchasing and installing the new equipment. Each of the major potential options should be analyzed and characterized in the same way.

The next step for each industrial task is to choose that combination of options that would at minimum cost provide the industrial energy services (e.g., steam) currently required, that is, choose a path that maximize energy productivity. The output of this effort would provide information on which supply and demand technologies could best provide an energy service (e.g., steam) for the entire industrial sector as illustrated in Table II or for a particular industry as illustrated in Table III. At a macro-level this information would identify for an LDC how far away it currently is from a least cost approach. It would

indicate, for example, what services could be provided less expensively through burning charcoal instead of using electricity or by installing heat recuperators to replace a portion of the oil consumed.

This data would be useful in examining current public policies that may interfere with achieving the least cost result. It may also indicate where limited capital funds (private or public) could best be allocated and can most certainly help give direction to education and training program in the energy field.

The technical options discussed above for meeting existing industrial energy needs typically require capital investments. There are however, opportunities in most existing industries in the U.S. (and presumably the same is true in LDC modern industrial sectors) for satisfying a portion of energy service requirements (5-20 per cent) through management actions that require little or no capital investments. Almost every major industrial concern in the U.S. can meet its current energy needs with less fuel or electricity through such things as improving fuel to air mixture on boilers, repairing steam leaks and traps, insulating pipes, scheduling machine start up times to reduce peak electricity demand (which would reduce the cost though not the amount of electricity) improving maintenance of energy equipment, repairing compressed air leaks and loading furances and other energy using equipment to efficient capacity levels. Undoubtedly, most LDCs could benefit from a program that stimulates these kind of actions by its major consumers of commercial energy. In Chapter 2, we noted that Korea had instituted a "heat audit" program of energy conservation that looked at both "housekeeping" energy improvements and capital-investments to do the same. The problem was that it lacked enforcement power and since higher operating costs could be passed on, they were. Hence, developing country governments may need to pass some enforcement measures in addition to stimulating energy efficiency programs through more R&D and training.

Table 15

Comparison of Efficiencies of Different Energy Technologies in the Creation of Industrial Steam, U.S. (1978)

Per Cent

Technology	Main Fuel	Efficiency
Atmospheric Fluidized Bed	Coal	82
Low BTU Gas	Coal	72
Medium BTU Gas	Coal	58
Boiler Air/Fuel Controls	Process Change	82
Heat Pump - Steam	Electricity	317
Poultry Process Modification	Waste Heat	60
Headbox for Paper	Process Change	82
Pulp and Paper Characterizations	Process Change	82
Hyperfiltration	Waste Heat	82
Low Level Heat Pump	Electricity	240
Foam Fiber Technology	Process Change	82
Solar Concentration	Sunlight	133
Solar Concentration/Fossil	Oil	144
Geothermal	Geothermal	100
Diesel Engine with Waste Heat	---	---
Boiler with Exports of Electricity	Oil	38
Diesel Engine with Waste Heat	---	---
Boiler without Exports of Electricity	Oil	57
Gas Turbine Engine with Waste Heat	---	---
Boiler with Export of Electricity	Natural Gas	41
New Coal Boiler	Coal	82
New Oil Burner	Oil	82
New Natural Gas	Natural Gas	82
Liquor and Wood	Biomass	60
Old Coal Boiler	Coal	70
Old Oil Burner	Oil	71
Old Natural Gas Burner	Natural Gas	70
Liquor and Wood	Biomass	60

1. This table shows the different technologies that are used in meeting the Steam service demand. The efficiency figures are based on experience in the United States and can only be illustrative insofar for the Third World.

2. Where efficiency levels exceed 100 per cent, fuels have been used either in cogeneration of more than one secondary form of energy (steam heat and electricity) or their efficiency have been artificially raised beyond normal levels--as in solar concentration.

Source: Dennis Bakke.

Table 16

Comparison of Efficiencies of Different Energy Technologies in the Making of Iron, U.S. (1978)

Technology	Main Fuel	Efficiency
Low BTU Gas	Coal	29
Medium BTU Gas	Coal	23
High Temperature Recouperator	Waste Heat	33
Cupola Furance Model	Process Change	33
New Coal Direct	Coal	33
New Oil	Oil	33
New Gas	Natural Gas	33
Old Coal	Coal	30
Old Oil	Oil	30
Old Gas	Natural Gas	30

1. This table indicates the technologies that capture the market for the iron making service demand. Efficiency figures are based on experience in the United States and do not necessarily apply to any developing country.

Source: Dennis Bakke.

Energy for New Industry

For many LDCs, providing energy services for new industry is of greater concern than what happens in existing industry. In countries where industrial growth averages 7 per cent annually (typical for many developing countries), as much as 75 per cent of the industrial capacity that will exist in the year 2000 has not yet been built.

Obviously, this new capacity will require energy services to make it function. In fact, we can safely assume that the demand for energy services will likely rise proportionately to the growth in industry. However, energy in the form of fuel use need not rise at the same time. In the U.S., for example, during the past seven years, industrial output in goods and services rose 12 per cent, while industrial energy (fuel and electricity) dropped 10 per cent. This amounts to an improvement in energy productivity of approximately 22 per cent.[7/]

Today in the U.S., a 4 per cent growth in economic activity requires an increase of only 2 per cent in energy use. A similar phenomenon is possible in developing countries. There is no overriding reason why industrial growth and energy use should be coupled on a one to one basis, if developing countries develop an energy strategy based on maximizing energy productivity.

One of the major strategic decisions related to energy for new industry is the selection of the type of industrial activity in which to engage. There is a tendency for energy specialists to over-emphasize the role of energy in this selection process. The potential market for the industrial product (world or local) and the future cost of the capital, labor and materials required are often more important than the cost of energy in deciding which industries to develop. Only when energy costs start mounting above 5-6 per cent of an industry's value added--e.g., in industries like cement, chemicals, steel, and other primary metals

Table 17

Energy Consumption by Industry in the U.S. 1971

Industry		Energy Consumption a/	Per Cent of Total	Energy Intensiveness b/
20	Food and kindred products	300.6	7.81	2.59
21	Tobacco manufacturers	5.5	0.14	0.76
22	Textile mill products	106.5	2.77	4.01
23	Apparel, other textile products	19.6	0.51	1.00
24	Lumber and wood products	68.4	1.78	4.32
25	Furniture and fixtures	17.8	0.46	1.54
26	Paper and allied products	385.4	10.02	7.47
27	Printing and publishing	30.1	0.78	0.98
28	Chemicals and allied products	814.2	21.16	5.67
29	Petroleum and coal products	466.9	12.13	11.33
30	Rubber and plastics, n.e.c.	66.3	1.72	2.79
31	Leather and leather products	9.8	0.25	1.43
32	Stone, clay, and glass products	382.3	9.93	7.75
33	Prima· · metal industries	716.7	18.62	10.00
34	Fabricated metel products	102.7	2.66	2.02
35	Machinery, except electrical	107.6	2.79	1.52
36	Electricial equipment and supplies	80.1	2.08	1.37
37	Transportation equipment	114.2	2.98	1.41
38	Instruments and related products	20.1	0.52	1.01
39	Miscellaneous manufacturing industries	10.4	0.47	1.52
	Total	3,847.1	100.00	

a/ Billions of Kilowatt-hours equivalent

b/ Energy cost as per cent of value added. Values added is a dollar measure computed by the U.S. Consus Bureau by subtracting the total cost of materials of an industry from the value of its production and then adjusting for inventory change.

Source: Dennis Bakke

and pulp and paper does energy become a major factor in deciding whether to engage in that industry (see Table I7). Even in these industries the cost of capital, and the future cost of materials are likely to override energy costs in determining whether a particular industry's output will eventually be able to compete with the same goods produced in other nations.

Normally an entrepreneur will invest in those industries that, after estimating the future labor, materials, capital, and energy costs, will produce goods that compete most favorably with goods produced elsewhere. In this kind of analysis it is important to use appropriate estimates of future costs. In the energy area, for example, a cost of charcoal that does not consider the likely increases in future labor costs in the charcoal manufacturing process or the costs to the environment--especially forest area--of increased demand for charcoal, or decreases in other costs due to improved manufacturing efficiency and improvements in transporting the fuel is not appropriate. Nor should the cost of electricity produced from an existing dam be used in the analysis if industrial project being planned would require the building of new hydro electric or other power plants with substantially different cost figures.

Once the idustry selection decision is made, the same type of analysis outlined for existing industry should be undertaken. Future energy services for heat mechanical motion and fuelstocks should be estimated and the supply and demand options for meeting those needs analyzed for their cost and share of energy service requirement each could provide.

Many choices are open to the entrepreneur in the case of new industries. He may choose between electrical and non-electrical energy for certain processes such as heating and shaft power. For his electricity needs, he may choose whether to buy from the electrical grid or generate his own electricity, perhaps using the heat remaining in the steam after it generates electricity, to perform an

industrial process. And, of course, if he generates electricity on-site, there are choices among energy sources such as coal, charcoal, oil and occasionally gas. In the future, it may be practical to examine whether photovoltaic cells, a power tower or a wind generator could economically be installed--especially where grid power is not available or is very costly. Even the use of unconventional energy sources such as wood and solar (for example for pre-heating water) may make economic sense when considered in the context of maximizing energy productivity and implementing the least cost energy strategy for new industry. However, in most instances, these sources and bio-fuels such as methane or alcohols do not appear to be technologically close enough to being cost effective to warrant routinely investigating them.

In addition to looking at the fuel options available, other options for meeting the demand for energy services in new industry are also available that use energy better. New synchronized electrical motors will be available that may cut electrical usage in half. Continuous casting of steel can capture an enormous fraction of the high temperature heat used in the steel industry. Some of these options will prove economically attractive for existing industry, but the reduced costs associated with building a new plant compared to refitting an existing one with new energy-related equipment make them especially attractive for new industrial development. An LDC can use this analysis to help decide which energy intensive-industries to favor but the principal benefits are the information it provides for selecting the least cost system for the industry and for analyzing future energy policies, including pricing, investment decisions, education programs, and energy R&D.

A Role for LDC Governments

In some cases, government is the industrial entrepreneur and in those cases the choices discussed above will be made by government officials. In other cases, private entrepreneurs make the decisions, but even in those cases, there is a

role for government. That role may include control of zoning, control of imports to ensure that imported equipment is energy efficient or does not excessively displace labor, and review of industrial plans to ensure that, for example, hookups from the grid are not made without considering cogeneration or that industrial charcoal is made from the trees of managed woodlots. An issue for each government to consider is whether government can play a role in improving energy productivity without adding too much delay, paper work, and corruption.

AID Assistance

The preceding discussion of energy in the modern industrial sector of LDCs suggests six potential areas for energy related assistance (see also Chapter IV for a more detailed discussion of AID activities):

1) Establish a program to collect data on current and future energy services required by industry. How much mechanical drive, high temperature steam, direct heat, etc.? Also characterize the cost and potential share of market of major supply and demand technologies that can satisfy each energy services sector requirement. This needs to be done for both refitting existing industry and building new capacity.

2) Support an effort to analyze the data collected in "1" in an effort to develop strategies that minimize the cost of delivering the energy services required.

3) Sponsor an analysis of which new industries should be established ensuring consideration of all relevant input costs. In most cases energy would be a relatively minor aspect of this effort.

4) Stimulate R&D activities on technologies that appear most promising for satisfying major portions of industrial energy demand.

5) Develop a program to assist individual industrial firms in auditing their plants and making energy productivity improvements.

This may involve helping build appropriate host country institutions --private or government. In the indusrialized countries there are firms which offer energy audit and are paid an agreed percentage of the savings that result from adopting their recommendations. To operate in the Third World, such firms would probably require some foreign assistance in the form of initial capital and perhaps a guarantee of payment in convertible currency.

6) Provide capital and support funds to demonstrate the application of the least cost energy strategy in a) one or two companies b) an entire industry or c) an urban area. Provide a capital fund to buy the equipment necessary to carry out the recommendations of the energy audit in # 6 above.

b. Small-Scale Industry

Many governments actively promote traditional crafts industries because sometimes they earn foreign exchange and frequently they create more jobs per unit of output than large-scale industries. As noted in Chapter II, energy plays a relatively minor or fixed role in the overall cost of production of many of these industries, so there is probably little need for concern at the particular plant level. However, in specific cases such as cloth dying and pottery-firing, some savings can be had with the use of heat recuperators and insulation and installation of efficient kilns. The issue in these cases is likely to be availability of capital for such a purchase (either through tax credits or subsidies) and a demonstration of its energy and financial cost-effectiveness. Other small-scale formal sector industries are not now great users of energy, especially in relation to the total value of the product although availability of electric power, in particular, is often indispensible. An example is the assembly of components. While individual small-scale industries do not tend to dominate energy consumption the way that large-scale industries do (see Chapter II), a successful development strategy of gradual industrialization must provide energy for small-scale industries.

It is usually small-scale industries that provide the largest share of off-farm employment in large market towns and small provincial cities. In some countries, the small-scale industries sector, in fact, has been the most dynamic sector of the economy.[8/] If a government seeks to discourage urban migration, for example, by developing these decentralized "growth poles" of development, their economic success will be enhanced by the provision of energy for power, direct heat and process steam.

In the past, this strategy has bumped up against the costly distributional problems of transporting petroleum products or electrifying outlying areas from the central grid. Thought should be given, therefore, to making such industrial

estates more self-sufficient. Governments should evaluate the possibility of setting up industrial estates with sources of electricity independent of the grid. Research and development efforts should be applied to finding affordable ways to upgrade renewable energy sources to high quality standards. This may already be possible for managed biomass-utilizing technologies (for power generation or direct heat). Governments consider providing incentives to encourage those small-scale industries whose energy needs are more appropriate to energy resources that are locally available. For example, they might encourage pottery or metal-working industries in areas where wood or wood wastes were plentiful enough to make into charcoal.

2. The Informal Sector

Unfortunately, many if not most governments actively seek to discourage the activities of the informal sector. This is done by favoring modern formal sector industry with tax benefits, easy access to credit, and the provision of services, including energy. It is also done indirectly by establishing elaborate regulations concerning unions, dismissal policies, product standards, and licensing of activities. Finally, informal sector activities are, in many cases, prohibited and subject to official harassment because such governments look upon the sector as embarrassingly unmodern and they see it as encouraging rural-urban migration.

Of course, the informal sector, far from withering away, has bloomed in adversity. Developing country governments should recognize the inevitability and value of the informal sector in a transitional economy (in fact, it exists on a smaller scale in developed countries, too.)[9/] Governments should work to improve the working conditions of and the products and services of the informal sector. But they must recognize that to try to do so by establishing still more regulations will not be successful.

Governments should minimize regulations barring official access to the market of products of the informal and small-scale quasi informal sectors. These standards are often unnecessarily high and may even go against the cultural desire of the people. More to the point, these goods already serve a very large segment of the urban population. At the same time, governments, possibly with outside assistance, should try to devise low-cost, improved technologies to upgrade product quality. Part of this effort could involve the extension of electricity or improved charcoal and wood-using furnaces and heaters. Extension of electricity should be accompanied by the availability of equipment loans or their easier rental and the establishment of officially-sanctioned zones (preferably where they now are) for operation. This last applies especially to back yard artificers. Regulations should also be lifted, where they exist, on the use of labor except in regards to worker safety and environment. Some thought should be given to the role of the minimum wage. In some areas, it is no more than the equilibrium wage rate, in other areas, much higher. Should it be a prescriptive rate or applied more selectively? Although the minimum wage rate has some energy implications, these cannot be dealt with here especially given the lack of information on the subject.

In macroeconomic terms, governments should allow much more use of those appropriate traditional materials often now produced or used by informal sector enterprises as part of formal goods production and should encourage the use of recycled materials, especially energy-intensive materials (which would be a job-creating endeavor.) Governments, possibly with outside aid, could investigate the feasibility of widespread production of consumer and intermediate goods with improved traditional technologies. India, for example, has achieved a measure of success by encouraging the production of khadi, the handspun thread that is woven into cloth by domestic cottage industries. There should be much more recognition of the critical role

of the informal sector in terms of its rural-urban linkages using rural material and labor inputs (especially recent migrants) as well as selling many of its goods back to the rural markets.

If governments do decide to encourage the informal sector, they should take care to work cooperatively with them rather than try to regulate them, a) because entry into many of the craft and service occupation is closely controlled by families, castes, and tribal relationships and does not necessarily represent a free labor market, (especially true in Asia and Africa); and b) because many of the products of the informal sector serving the low-cost needs of the mass of the urban poor are very culture specific and not necessarily amenable to modern, Western technology except at signficant cost. Hence, imported quality standards often adopted by governments might be inappropriate.

The role of aid organizations in the informal sector should be to finance surveys and analyses to describe the use of energy in the informal sector and identify the potential savings of commercial energy. Surveys could also identify the effects of regulations--whether they encourage large-scale industry at the expense of small-scale industry and the informal sector, whether they tend to smother the latter two, and what changes might be made. Aid donors can also help finance R&D on improved traditional technologies, the extension of urban electrification, and R&D on modern renewable energy alternatives applicable to small-scale industry (e.g., the use of direct solar heat applied to solar welding.) They could help finance small loan funds to enable small industries and backyard artificers to improve their use of traditional technologies.

3. Energy for Government and Commercial Buildings

Urban centers in LDCs contain commercial office buildings, hotels, and government buildings similar to those in the developed nations. Many of the buildings were built by contractors from the North and contain the same opportunities for energy productivity improvements that exist in the U.S. In addition, the growth in new commercial buildings is substantial and the future need for energy services in these buildings is great. The sections that follow discuss providing energy services first to existing and then to future structures in this sector.

Existing Commercial Buildings

Unlike the residential buildings sectors in LDCs, hotels, government structures and commercial buildings contain amenities similar to those found in industrialized nations. They require energy for services like space heating and cooling, water heating, lighting and mechanical drive (operating typewriters and other business machines) similar to buildings in the U.S. As in industry, our approach to the existing buildings sector should focus first on how much of these services is needed. How much space heat? How much light?

Table V illustrates the kind of energy service and collection effort that is needed, although it is too detailed for most LDC's. Obviously, adjustments would be needed to account for the uniqueness of each LDC.

Energy services needed by buildings can be provided, at least partially, from many different sources. Making a room warm, for example, can be acomplished by using oil, gas, wood, or electricity (from a variety of sources). It can also be supplied by demand technologies such as more efficient furnaces, insulation, and systems for reducing the use of cold outside air for ventilation purposes. Each technology can potentially supply commercial buildings with warm rooms. The question is which mix of the options provide the service at the minimum cost. To make such a determination requires data on how much of the service can be provided at what

cost by each competing system. For example, a hotel room can be cooled to the desired temperature in the summer with a certain amount of electricity powering air conditioning equipment. Alternative, 25 per cent of the cooling service can be provided by special window glazing materials that reject the sun's heat. The question is, which option is less costly--the electricity or the glazing.

Thus, to develop an energy strategy for existing commercial buildings, one must first quantify the amount of energy services currently demanded. One then should analyze all major potential suppliers of those services for relative cost and the amount of the service each option can provide. Finally, one should identify those combinations of options that would at the least cost, provide the buildings with the required services. The results of such an analysis are illustrated in Table 19, showing which technologies could have supplied the 1978 commercial and residential buildings energy service markets in the United States, compared to the technologies that actually provided the service. A comparison of how this mix of technologies corresponds to the actual situation identifies how far the United States has strayed from a least-cost strategy. It indicates, for example, that services could be provided less expensively through the purchase and installation of more efficient and cooler lights rather than the continued generation of electricity. This information can be helpful in identifying public policies that may interfere with achieving the less costly results and those that can best meet the least-cost objective.

While this type of analysis may identify signficant opportunities for energy productivity improvements in the buildings sector as a whole, it will not substitute for audits of individual buildings to determine the potential options unique to the building. Obviously, many of the alternatives for improving productivity involve capital investmenst--e.g., switching to another fuel source, adding insulation, and purchasing more efficient lighting. However, our U.S. experience has shown that much improvement is also possible without substantial investment in new equipment.

Table 18

Ilustrative Commercial and Building Energy Services Requirements

Line No.	Building Types (AIA Classifications)	Space Heat	Air Cond.	Hot Water	Refrig.	Dryers	Range	Misc.	Total
1	Assembly								
2	Elementary School								
3	Secondary School								
4	College								
5	Hospital								
6	Clinic								
7	Office								
8	Mercantile								
9	Restaurant								
10	Warehouse								
11	Residential Non-Housekeeping								
12	Residential Housekeeping								
13	High Rise Apartment								
14	Miscellaneous								
15	TOTAL CONSUMPTION								

Source: Dennis Bakke.

Table 19

RESULTS FOR THE 1978 ACTUAL AND LEAST-COST CASE (10^{15} Btu)

	1978 Actuals	1978 Least Cost
Oil Burner	4.37	1.38
Gas Burner	5.96	3.13
Electric Resistance	0.35	0.27
Electric Heat Pump	—	0.09
Gas Heat Pump	—	—
Solar Collector	0.02	0.03
Central AC	0.87	0.59
Appliances/Aux.[1]	3.19	2.22
Coal	—	—
Cogeneration Oil Used	—	2.29
Gas-Thermal	1.66	1.75
Electric-Thermal	0.47	—
Solar-Thermal	0.01	0.02
Oil-Thermal	0.40	—
Solar Back Up	0.01	0.01
Electrical Losses	11.98	8.56
Structures[2]	—	5.59
Improved Burners[3]	—	1.75
Improved Appliances[3]	—	0.97
Cogeneration Displaced Fuel[3]	—	0.64
Total	29.29	29.29
Actual efficiency improvements since 1973	0.74	0.74
Implied total[4] without improvements after '73	30.03	30.03

[1] Includes miscellaneous household appliances in the residential sector and venting distribution, and transport equipment in the commercial sector

[2] The efficiency improvement includes benefits attributable to the combined operation of improved structures and improved HVAC equipment. Subsequent references to efficiency improvement due to structures omit this cross term, estimated to be 0.71 quads

[3] Increased efficiency is represented here as fuel saved

[4] Projected fuel use if market forces were identical to those before 1973

Operational and scheduling changes alone can improve productivity 15 to 30 per cent in the U.S. e.g., using cool outside air for space conditioning a building during some parts of the day, opening or closing drapes during appropriate seasons and times of day, reducing use of exhaust systems during other times, setting back thermostats during unoccupied hours, and increasing the use of task lighting.[10/] A program to exploit these opportunities should be part of an LDC's energy strategy.

Energy for New Commercial Buildings

Energy for new buildings may be more important for LDC's than existing structures. By the year 2000, 60 to 80 per cent of the commercial building space that exists will have been built after 1979.[11/] These new buildings will require energy services similar to those that exist today. The demand for fuels to supply these services may not, however, rise in proportion to the amount of new commercial building space. Some estimates in the U.S. indicate that new buildings can be constructed and operated with as much as 70 to 80 per cent less fuel to provide the desired energy services compared to structures built in the last 20 years.[12/]

To determine whether this would be appropriate for an LDC and to develop a strategy for new buildings, a developing country should embark on the same type of analysis outlined for existing buildings. What are the energy services required by future buildings? What options are available for supplying these services and what do they cost? What is the cheapest mix of available options for meeting future needs?

From this analysis, an LDC should be able to determine which fuels can most cost-effectively supply buildings, what kind of conversion technologies (heating, cooling, ventilation systems) should be adopted, where to build the structures, how they should be oriented to the sun, whether solar technologies make sense, what

lighting systems to install, how much glazing and insulation to use and whether cogeneration of electricity (for lights and air conditioning) and heat (for water and rooms) is attractive.

This information can assist private developers as they design and construct new buildings. It can also serve LDC governments considering energy building standards and other policy initiatives to reduce the future cost of delivering energy services to the government and commercial building sector.

Foreign Assistance

Assistance possibilities in commercial buildings are similar to those in the modern industrial sector:

1. Establish a program to collect data on current and future energy services required. How much lighting, space heat, space cooling, and mechanical drive? Also, characterize the cost and potential share of market of major supply and demand technologies that can satisfy each energy service sector requirement. This needs to be done for both refitting existing buildings and new capacity.

2. Support an effort to analyze the data collected to develop strategies that minimize the cost of delivering the energy services required.

3. Stimulate R&D activities on technologies that appear most promising for satisfying major portions of energy services requirements in buildings.

4. Develop a program to assist individual building owners and managers in auditing their plants and making energy productivity improvements.

5. Provide capital and support funds to demonstrate the application of the least-cost energy strategy in one or two buildings, in all the buildings of a particular type (e.g., hotels), or in all commercial buildings in an entire urban area.

6. Improve the capability of the local equivalent of the Bureau of Standards to identify the degree of efficiency of air conditioners being imported.

4. Households

In this section we consider 1) the major problems that must be faced by governments (national or municipal) concerning household energy use in urban areas and 2) how outside aid programs can help governments resolve those problems.

a. Major Decisions Governments Must Make

One of the major decisions governments must make is what source of electricity to use. This will not be discussed here since it is covered elsewhere. The major household energy needs are cooking, water heating, space heating, ana electricity for lighting and household appliances. In the homes of the poor majority, the overwhelming energy use is for cooking.

The main source of cooking fuel in Third World cities is fuelwood or charcoal. Most cities will have to continue relying on these fuels for want of a practical alternative. The chief decision governments must face is how to increase the supply of wood and use more efficiently what is available. Producing more wood for urban use raises questions of how to protect the forest reserves against illegal cutting; how to encourage private entrepreneurs to grow wood commercially; how to improve land tenure systems so that entrepreneurs have title to land and rights to the wood grown upon it so that there will be an incentive for them to plant and care for trees; and how to encourage villagers to grow community woodlots for their own use (because they may compete with urban users for scarce wood).

Charcoal raises a special problem for governments. Some experts advocate that charcoal production be discouraged because it is so wasteful of the energy in firewood; usually more than 80 per cent of the firewood's energy is lost in the manufacture of charcoal.[13/] Others point out that charcoal is easier to transport than wood and more efficient in heating the pot. Moreover, they argue, whatever the energy loss may be, people will continue to use charcoal because of habit and preference so governments, instead of supressing charcoal production, should encourage producers

to use better kilns to cut the loss of energy in the process of making charcoal. Some governments are considering subsidizing the use of better kilns. A number of them now subsidize the consumption of charcoal by imposing price ceilings on its sale within the city. They do so because poor people in the city could not afford to pay the free market price but, of course, they recognize that this makes no sense from the point of view of conserving their forests (any more than it makes sense for the United States to subsidize the consumption of gas or gasoline.) These are tangled political and economic problems that many LDCs face.

A few countries have decided or are considering encouraging urban households to use imported petroleum products for cooking. This is a troublesome course of action given the prospect of oil shortages and price increases. But for some countries, it may appear as a lesser evil than continued deforestation.

The use of better stoves to improve the efficiency of wood and charcoal is a course of action now under study in several LDCs. One important problem is to ensure that the particular stove being recommended is more efficient than the local traditional cooking method. Third World women know with considerable accuracy how much wood they use with the traditional method. Unless the stove performs perceptibly better, it will not be widely adopted. A second problem is that people may not have the money to buy a stove even though it saves money in the long run by using less fuel. This again raises the question whether to subsidize the distribution of stoves.

If other sources of energy for cooking such as coal or peat are available locally, this will raise the question what government action is needed to get production under way. In some countries, animal and vegetable wastes may be plentiful and easy to collect, or human waste may be used for fertilizer. In such cases, it may be that governments should encourage the use of anaerobic digesters to produce methane gas for cooking. Two additional advantages are that the slurry remaining after extracting methane gas is a valuable fertilizer and that the process kills germs

and parasites present in human waste that may cause diseases. Government decisions include what design to use, whether to encourage family or community digesters, how to organize the latter and, of course, whether and if so how much, to subsidize its costs.

Solar cookers have not proved to be acceptable for cooking in rural areas. Some countries may wish to test them in urban areas to see if there is a better cultural fit. Since urban people must pay cash for wood or charcoal, there may be more of an inducement to use solar cookers. Also, solar hot water heaters may prove practical for those homes that can afford hot water. In areas where fuel is used for space heat, solar space heaters may be attempted.

In all of these options, governments are presented with the question whether to subsidize. The answer will vary according to local circumstances but, in general, it would seem to be adviseable where it is politically acceptable to limit subsidies to the production of energy or its conservation and to avoid subsidizing consumption.

b. A Role for Aid Agencies

Aid agencies can help developing countries resolve these problems associated with household energy in several ways.

This might include surveys to learn more about present household use of energy, householder preferences and levels of efficiency; R&D and site testing of stoves, kilns, solar cookers, and solar water and space heaters. It might include a wide variety of training and institution building activities. It might include help with forestry and woodlots, in and near cities. It might include financial help to subsidize production or purchase of stoves, kilns, or a variety of solar and other energy production equipment.

5. Construction

We have singled out construction for special discussion because it has a great and long-lasting impact on energy use. Most of the buildings (factories, hotels, stores, offices, and homes) and infrastructure (sewage, power, water, and streets)

that will be in existence in the year 2000 have yet to be built. A varying but probably significant portion of the commercial energy used in a Third World city is devoted to construction and to heating, lighting, cooling, and operating building machinery in buinesses and homes. The construction industry in many Thrid World cities is particularly inefficient. Hence, it deserves a brief discussion apart from other industries. We will examine three clusters of decisions that must be made by the contruction industry in Third World cities: decisions on (1) building design, (2) building materials, and (3) building methods.

a. Energy Efficient Building Design

The construction industry in the Third World typically consists of a few large companies and many small ones, with the large companies--often foreign-owned--controlling most modern construction. Decisions on design of structures tend to imitate unthinkingly the designs used in the Northern industrialized countries often featuring buildings that are completely dependent upon artificial cooling and (less frequently) heating, even where the outside climate lends itself to cooling and warming by natural means. The use of Northern architects or Northern-trained architects to design buildings may contribute to this tendency.

The present incentive system governing building design, in developed countries of new structures pushes them to cut initial construction costs. Given the often high energy-intensive material component (often imported) of these designs, it is not clear that these designs can be built cheaper than local designs adapted to using locally available materials and skills. But, in addition to this, inadequate attention is given to designing specifications that would cut the operating costs of the structure over its lifetime even at some increase in initial costs. These operating costs consist largely of the energy costs of space heating and cooling, lighting and building machinery. Thus, changes in construction design to emphasize

energy efficiency could have an enormous cumulative effect on energy use in the cities of the Third World.

b. Energy Conserving Building Materials

In some developing countries, as much as 60 per cent of materials used by the construction industry is imported.[14/] In part, this is due to the lack of an indigenous building materials industry. Such industries need to be developed to produce basic conventional building materials (e.g., a timber industry). More work is needed by indigenous scientists and others in the construction industry to use local building materials in innovative ways taking advantage of local materials that have exceptional insulating qualities, for example. In some instances, existing codes inhibit the innovative use of building materials by requiring that conventional materials be used.

c. Energy-Productive Building Methods

Present building procedures in the Third World, although somewhat more labor intensive (per unit of investment) than in the industrialized countries do not employ as many laborers in proportion to population as in the industrialized countries.[15/] In part, this is due to the fact that the large foreign-owned construction firms tend to follow the construction procedures they are familiar with in the North. It is also due to the fact that design specifications even force small contractors to use less labor intensive methods, requiring, for example, that in order to qualify for bidding, a contractor must possess a certain minimum amount of equipment.[16/]

Substantial improvements in energy efficiency would be possible simply by better management techniques on the construction site. There is a great need for programs in Third World countries to train small contractors.

d. Least Cost Construction

Application of the least cost approach to the construction industry should begin with a careful statement of the services to be performed by the structure (e.g., a

given area of space at a certain temperature range). Then a range of alternatives should be explored to find the combination of design, building materials, methods, and equipment that will provide that service over the lifetime of the structure at least cost.

e. Assistance Activities

Aid agencies can help by supporting several kinds of programs.

(1) Help to build an adequate local design and construction industry. This will call for steps to strengthen the construction industry, for example, by adding courses on the use of local materials, and adaptation of imported materials to local climate and other conditions in the local schools of engineering, or by training architects and engineers in schools outside the country. Care must be taken to ensure that such training does not reinforce the existing bias to use designs, building materials, and methods suited to the industrialized North.

(2) Research and development of new and energy efficient ways of using local building materials.

(3) Compehensive studies of the construction industry in a city or an entire country identifying opportunities to improve their ability to attain least cost construction services.

(4) One or more detailed case studies of how the least cost approach might be applied to a given building project. These studies--which could be conducted by local scholars--will be needed to produce the teaching materials needed to train designers, engineers, and contractors in the least cost approach.

(5) A great deal of R&D is being done in the North on energy productive building design, building materials and construction methods; aid agencies should seek ways to make this information available to LDCs.

6. Energy for Urban Transportation

The establishment of a transportation system for farm to market movement of goods is a significant event which is associated with the transition of a country

from subsistence to developing status. In fact, in most LDCs, transportation accounts for a substantially greater percentage of total energy consumption than in the developed countries, even though the per capita consumption of transportation energy is significantly less. As countries develop, transportation traditionally decreases in terms of its share of total energy although per capita transportation energy consumption increases substantially due to increased discretionary travel. To the extent that land use patterns in a developing country have not yet been firmly established and transportation infrastructure investments have not yet been made, that country has more freedom in dealing with transportation energy than do its more developed counterparts. In general it can:

(1) Reduce the quantity of transportation services required for a given level of personal and commercial activity, or

(2) Reduce the cost of required transportation services through increased energy productivity and judicious choice of fuels. Many developed countries are for all practical purposes constrained to policies affecting only the latter method of attack because their patterns of land use and their transportation infrastructure are already well established.

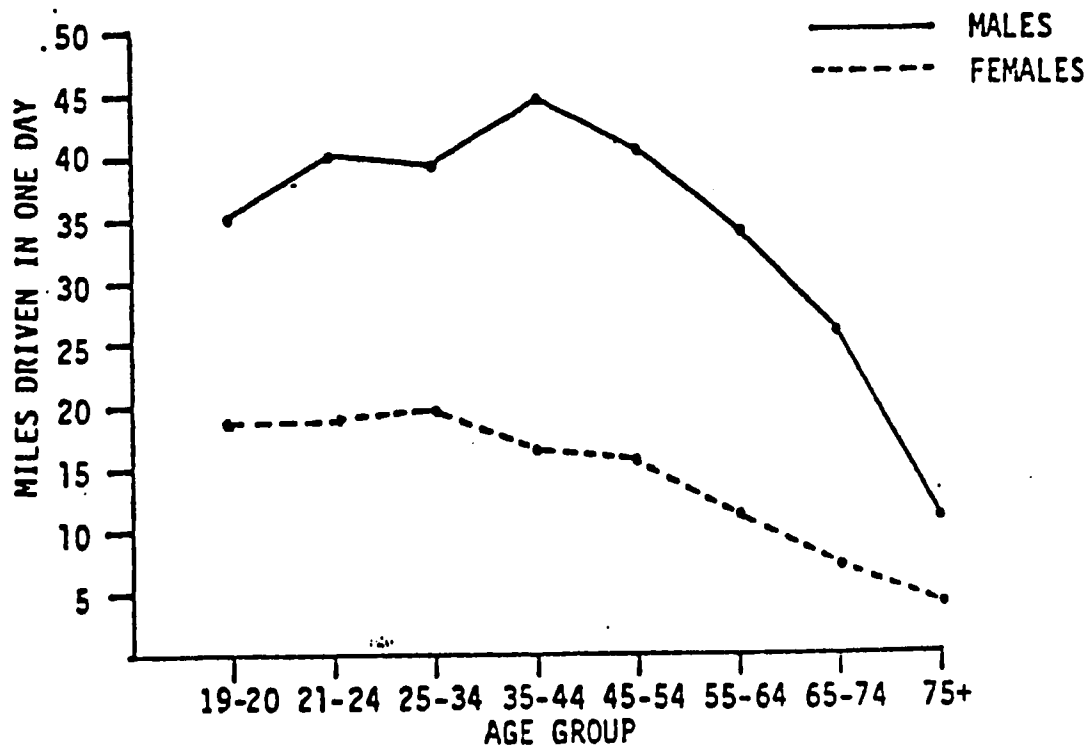
a. Reduction of Transportation Demand

Figure 1 indicates personal travel behavior which is typical of the current mid-western United States. It is the consequence of increasing disposable personal income, a desire for mobility, and a series of government policies that encouraged low density residential development and extensive highway capacity. Post World War II Western European countries have experienced similar trends: increased automobile ownership, a move to the suburbs, and annual miles traveled per vehicle comparable to that of the United States.

But such a trend is not inevitable. The methodology of transportation planning has developed to the point that it is possible to estimate with a reasonable degree

FIGURE 1

AVERAGE MILES DRIVEN PER DAY



Source: Lee, Martin, Some Basic Results from the Michigan Driving Experience Survey, Michigan Department of State, January 1979

of accuracy the transportation demand which results from a given pattern of land use. In most developed countries, however, this methodology has been applied only for the purpose of determining the location and capacity of roads and other transportation facilities needed to serve a land use pattern which had already been determined. The LDC, on the the other hand, has the opportuntity of establishing as an objective the minimizing of transportation demand, and testing alternative land use policies against this objective.

For example, in an LDC, the work trip may account for more than half of the total urban passenger travel demand (in developed countries this share drops to 20 to 30 per cent due to increase in discretionary travel) suggesting that a land use policy which provides for desirable residential housing in close proximity to work location could play a major role in reducing transportation demand for the same level of employment.[17/] For similar reasons, decentralization of shopping activities could help to reduce the demand for the next largest component of urban transportation service.

In addition to its impact on overall transportation service demand, the land use pattern also influences the choice of appropriate transportation technology to serve the city. The common example of this influence is the distinction between the diffuse land use patterns of typical American suburbia, which can be served effectively only by roads and personal (or very small public) vehicles; and a development pattern consisting of corridors or high density clusters which can be served effectively by a high capacity, line haul system such as rail. The energy implications of these technological alternatives are considered in the next section.

b. Transportation Energy Productivity

Once the transportation service demand (expressed in passenger miles and ton miles per day) has been determined as discussed above, a number of transportation technologies are available to service this demand with signficantly different levels of

energy intensity (BTU per passenger mile). For example, in 1976 the U.S. automobile fleet averaged about 4300 BTU per passenger mile, commuter rail transit about 3500 and bus transit about 3000.[18/]

Two compatible strategies are available to the planner: the selection of energy-productive (low energy intensive) transportation modes, and improvement of the efficiency of utilization of each of the selected modes. For example, the selection of a rail system for a dense corridor could achieve greater energy productivity than attempting to serve this corridor through private automobiles at typical accupancy rates. On the other hand, if auto occupancy rates are increased (through ride sharing or jitney services) the automobile can be made quite competitive with rail in many applications.

Having specified the tranportation service demand in terms of passenger and ton miles, it becomes possible to test alternative technologies and to estimate the energy consumption of each alternative serving the same demand.

The construction and maintenance of transportation facilities and equipment typically consumes as much energy as does the operation of these systems during their lifetime. This fact tends to argue against the construction of major new transportation facilities in developed cities where a stbstantial transportation infrastructure already exists. Some LDC cities, on the other hand, do not suffer from this constraint. Some sort of transportation infrastructure must be built, and energy will be consumed in its construction, but the choice of system technology may be still open. Therefore, some LDCs may have the opportunity at little or no net energy cost, to build the combination of rail, subway, and private vehicle highway systems which lead to the minimum total cost path.

c. Fuels

Although consideration of the cost of fuel is an inherent part of the selection of the minimum cost path, there are characteristics of the transportation sector which

require special comment with regard to fuels. The availability of cheap (and apparently unlimited) petroleum during the first half of this century has had such a strong influence on transportation choice in the developed countries that it is difficult to be objective in viewing transportation options. An LDC which has indigenous energy resources other than petroleum should consider those resources very carefully in its choice of transportation technologies. The relatively high capital cost of electric rail systems for urban corridors may be justified in part if it enables this transportation system to operate on less expensive indigenous fuel resources, (e.g., hydroelectricity).

d. Assistance Activities

Aid assistance possibilities in the urban transportation sector include application of modern transportation planning techniques to the objective of energy productivity, and the implementation of the technologies found to be appropriate. Specificially:

(1) Establish a program for training of urban and transportation planners in the techniques of improved energy productivity.

(2) Support the development of alternative land use and transportation plans and analysis of their energy productivity.

(3) Stimulate R&D activities in energy productive transportation technologies . . . particularly those capable of utilizing indigenous energy sources and smaller vehicles.

(4) Support research into tax policies and other incentives for encouragement of land use patterns capable of being serviced by energy-productive transportation.

(5) Provide capital and support funds to demonstrate the application of the least-cost energy strategy to an urban corridor or sector.

7. Urban Forestry and Fuelwood

A number of issues need to be addressed in considering policies which would begin to optimize wood production in Third World cities.

The problem of space is particularly important. There is no doubt that lack of space (especially for the poor) is a limiting condition in forestry in many urban areas. Part of the problem in obtaining access to space in many cities relates to land tenure and land registration obstacles. In Jakarta, for example, only 35 per cent of the rights to have land had been registered by 1973.[19/] In Africa, a tradition of communal land ownership makes the establishment of private plots difficult in some areas. In other areas, land hoarding in the cities by a few families has greatly limited the availability of growing space. The government of Nigeria sought to remedy this situation by passing an order in 1976 which limits each family in the city of Lagos to owning only one plot of land.[20/]

It is important to point out, however, that these problems reflect social questions regarding the use of space and not physical restrictions in the amount of space available. There are substantial amounts of unused or under-utilized space even in the most crowded cities. In the metropolitan area of Buenos Aires, for example, there are more than three vacant lots for each one that is built upon. A United Nations study found this pattern to be typical in many Latin American cities.[21/]

Another major deterrent to greater forestry production in Third World cities, is the lack of official interest and the consequent lack of an institutional framework in most cities to coordinate and undertake programs. The urban projects sponsored by international agencies reflect this lack of unifying purpose. Even the data which does exist for given urban areas is not regularly exchanged among LDCs and donor agencies.

Areas for Assistance

1. A tremendous need exists to inform Third World decision makers and donor agencies of the benefits of maximizing the productive use of urban land. Every opportunity to do this should be explored, for example, educational seminars or mini-confernces for Third World urban leaders.

2. Projects are needed that compile existing baseline data and gather that which has not yet been aggregated for urban areas; e.g., there is a need for case studies that encourage official interest in the problem by describing and measuring the urban forest potential including a plan for achieving a sustained harvest of urban trees. Among other things such case studies should inventory vacant land in the city to help officials deal with the problems of lack of land.

3. Assistance might be given to urban forestry projects in Third World cities which seek to encourage maximum community participation; special attention might be given to projects which involve women in urban forestry.

4. Projects are needed that seek innovative ways to recycle urban wastes in Third World Cities.

Chapter IV - Aid to Third World Urban Energy: A Suggested Methodology

This paper has demonstrated that Third World countries face daunting obstacles in meeting their needs for urban energy, that resolving those urban problems is fundamental to their development progress in the countryside as well as the city and that there are many opportunities for aid agencies to help. In Chapter III, we identified a number of such opportunities for each of the seven sectors discussed. In the paragraphs that follow, we will summarize these aid opportunities under four steps involved in a systemmatic methodology for providing aid to meet the energy needs of Third World urban areas.

1. Get the Facts

Each country and city is unique. Very few generalizations could be made that would apply universally. Hence, a great deal must be learned about the local scene in each country before one can identify courses of action that could respond to the local problems effectively. Helping to get that information is a high priority for aid agencies. But it is important to avoid surveys that collect data when reasonably good information can be obtained without a special survey. Frequently information on energy flows and consumption patterns is already in the files of utilities, large petroleum producing or selling companies, or in government offices. The first step is to learn what data exists before generating more. But if essential information does not exist, then aid agencies can help to develop it. Some authorities have urged that data collection be limited to information that is needed for a specific activity to be undertaken in the locality where the information is obtained.[22/] They are concerned that individuals may be interviewed at some length and then never see any results come from the interview. Hence, their goal is that at a minimum all of those people whose expectations are aroused by the survey see some tangible results in their own lives as a result. This is a useful target but it should not preclude the collection of information needed to let planners

at the city or national level understand the problem comprehensively. Thus, a survey of a neighborhood may be followed by actions that only affect cooking in that neighborhood but there is no reason information should not be collected on energy problems that range well beyond cooking if national planners or global scholars need such information.

Information is needed to help the host government and host country investors make two basic kinds of decisions.

a. Data to Enable the Host Government to Develop a Sound Urban Policy

A comprehensive coverage of this topic is beyond the scope of this paper which is limited to energy. But the basic decision on whether to design an urban policy to resist and reverse migration or a policy designed to live with it is so important to the future energy regime of the city that we will mention two kinds of information that will help make that basic decision. First, aid agencies can sponsor studies of what is causing migration. Second, they can finance studies of the effectivenes of various government efforts to slow or reverse that flow. In both cases, it would be preferable if the studies were performed (or at least participated in) by local experts.

b. Data to Enable the Host Government to Develop Sound Energy Strategies

1) Studies of Energy Efficiency

Aid agencies could support a series of studies of energy efficiency. These might range from comprehensive surveys of an industry, an entire sector, a city, or even a country to very specific studies of individual establishments. Studies could include each of the seven urban sectors discussed in Chapter III. In industry and small industry, for example, a study would very likely concentrate on equipment, industrial process (e.g., for fabrication or assembly) plant layout, materials used and energy source among other topics. Commercial establishments' use of energy for air conditioning (e.g, hotels) could also be examined. With respect to government

services, a potentially fruitful field for inquiry is how urban waste is disposed of and how it might be used as an energy resource. In each study, current energy practices would be evaluated, inefficient practices would be noted and opportunities for improving energy efficiency would be identified. Insofar as possible, their potential would be quantified as well as the cost of any changes recommended.

Wherever possible, such studies should be carried out by local experts. In general, local experts combine superior knowledge of local conditions, and language facility with very low costs for conducting the study. Where local people lack the technical qualifications for the study, it may be useful to bring in a temporary outside consultant to advise the local expert.

These studies would be an essential step in raising the awareness of decision makers of the gains that are possible through improving energy productivity.

2) Case Studies of How to Apply the Least Cost Approach to Energy

Such studies might be conducted in any of the seven urban sectors as well as in overall urban design. For example, in industry an expert could help a specific entrepreneur define and quantify the energy services needed and the price out the various ways of supplying those services. At a more comprehensive level help in applying this same approach could be offered to those planning the transportation layout for an entire city. It would be useful if a number of such case studies could be conducted in order to test how the least cost method could be applied in Third World areas where essential basic information is often lacking and some trail blazing is needed in correctly costing environmental damage and other costs external to the establishment. These case studies would be essential teaching materials in training others to apply the least cost method.

3) Research and Development on Energy Technologies

Aid agencies could support local R&D and adaptive R&D on equipment that produces energy as well as equipment that improves the efficiency of energy use.

For example, this might include adaptive R&D on how local geothermal energy potential could be used for urban district heating; R&D on new uses of traditional building materials; R&D on stove and kiln design; R&D on gasohol and alcohol production from various local organic materials; and R&D on local biogas generation from city wastes.

4) Site Testing of Energy Equipment

Aid agencies might finance and supply technical expertise to help conduct site tests of energy equipment. This might include, for example tests of heat recuperators, improved furnaces or solar water preheaters for industry; tests of solar cookers for small industries such as bakeries or breweries; or tests of kilns to produce charcoal or stoves to use fuel with increased efficiency.

2. Make the Facts Available to Policymakers

The fate of too many studies is to be filed in oblivion. Since we have suggested many studies above, it is important to say something about ensuring that such studies get used. The need is to find ways of sifting from the data available the nuggets of action needed by policymakers and to bring those actionable items to their attention.

In the United States, a host of non-governmental organizations (and some governmental) perform this service. For example, Brookings, the Overseas Development Council, the International Food Policy Research Institute, the Council on Foreign Relations, the Carnegie Endowment, and many other research and public education bodies scan the literature and write their own readable and always policy-oriented materials aimed at public policymakers among others. Examples are ODC's annual "Agenda for Development", and Carnegies' quarterly "Foreign Policy". Many other techniques are used also such as Carnegies' "Face to Face", ODC's dinner and luncheon seminars, Stanley Foundation's retreats at Airlie House, The

Johnson Foundation's conference center at Wingspread and the panels of the National Academy of Science. Likewise, the many nationwide trade fairs, business conferenece and Chamber of Commerce's publications make new technologies and management techniques widely known for the business community.

In attempting to use these or other techniques to ensure that valuable information finds its way from studies to policymakers and entrepreneurs in developing countries, aid agencies might insist that all proposed projects that will result in studies include in the project a sequel to the study which would be a plan for marketing the essence of the study to the relevant target audiences. For example, one technique might be to involve quasi-government/quasi-academic insitutions such as has been done by the Tanzanian UTAFITI or the Kenyan Council on Science and Technology in such projects at least in a review and dissemination capacity. Aid projects might provide that a highly readable version of the project findings be published locally perhaps as a serial in a local paper. An LDC equivalent of an Airlie House retreat or an ODC luncheon or dinner seminar could also be tried. The efforts of existing regional groups that are trying to deal with modern and urban energ consumption already, like the Asian Productivity Organization, should be encouraged and their results disseminated.[23/]

The best way to ensure that policymakers are siezed with the information coming out of a study is to involve them at some stage in the analysis that leads up to the final report. There is no shortage of ways to do so. They need to be identified developed and applied in each country.

3. Improve Local Capabilities in the Energy Field

a) Train people. Local capabilities depend on trained local people. Aid agencies can do a great deal to improve local capabilities by offering a broad range of training opportunities in donor and Third world counties including but not limited to planners, experts in oil, gas, coal, hydro and solar energy, and energy auditors for industry, buildings, transportation and utilities.

b) Build institutions that train people. Help might be given to Third World universities, special institutes, solar energy laboratories, and others to strengthen their energy training capacities.

c) Build public institutions with operating responsibilities in the field of energy. Aid agencies could provide technical and budgetary support to energy planning bodies and to government resarch institutions, and could help establish an energy capability within those public agencies, for example, that are responsible for zoning, for import control, and for industrial construction and commercial licensing.

d) Build private capabilities in the energy field. Aid agencies could help to establish or improve the energy capabilities and awareness of a variety of private facilities including, for example, consulting firms that could help industries and businesses to assess and rationalize their internal energy systems, a local energy conscious building materials industry, local design and construction firms conscious of the energy embodied in their industry, and manufacturers of energy producing or energy saving equipment.

4. Help to Finance Urban Energy Activities

In those cases where a country has made up it mind on a course of action, aid agencies may be asked to help finance substantial energy programs. This might take the form of 1) balance of payments assistance to finance the importation of energy saving or producing machinery; 2) local currency for small loan programs to help industry install energy productive equipment or decentralized renewable energy equipment; 3) financing of costs of improving urban transportation systems; 4) financing energy projects such as hydroelectric generating equipment, gasohol or use of urban waste to produce energy; 5) financing local energy equipment manufacturing facilities such as solar waterheaters, photovotalic assembly plants, mini hydroelectric turbines and generators, and bio-digester parts.

Footnotes

Introduction

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