



Pergamon

0360-5442(93)E0025-I

Energy Vol. 19, No. 5, pp. 503-508, 1994
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 0360-5442/94 \$7.00 + 0.00

HOUSEHOLD ENERGY USE AND ENVIRONMENT IN ASIAN CITIES: AN INTRODUCTION

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(Received 10 June 1993)

In the poorer countries of the world, where energy consumption per capita is lower than in the industrialized nations, the process of rapid urbanization is a strong feature of the dynamic of economic development. Population growth rates in cities are consistently higher than in the countryside, due both to higher natural increases and to net migration. Although the majority of Asia's population is still rural, this dominance is expected to shift sometime around the turn of the century. Already, developing countries in Asia have at least 16 cities with populations exceeding five million persons. And the development of megalopolises, which link several large cities in a closely related urban region, is emerging as a typical evolutionary pattern (e.g., in Western Java or Taiwan).¹

Cities are the focal points of economic activity, accounting for the bulk of regional GDP and growth. They have active and often efficient markets, providing diversity of choice, one of the main attractions of urban life. As Asian economies grow, driven primarily by the transactions and production of the region's cities, this trend is only likely to be reinforced.

Urban lifestyles are readily adopted as the way of the future. At the same time, cities are characterized by sharp disparities in income, living conditions, and access to basic services, between those social groups that have managed to capture the economic benefits of rapid growth, and those that have not.

I. THE ENERGY-URBANIZATION LINK

The increasing importance of cities means that fuel choices, consumption levels and patterns of energy use by urban households will have a significant impact on national energy policy context. Energy development also will bear heavily on countries' abilities to meet development objectives in terms of all the major dimensions of economic growth, environmental quality, human health and welfare.

Urbanization and the growing demand for modern fuels are elements intrinsically linked to the transformations of economic structure, location and human lifestyles that we refer to as "economic development." Of all sectors, the household sector experiences the most pronounced changes in patterns of fuel use. In urban areas, while energy is needed by households for the same basic tasks as in the countryside, the choices available to residents are much more varied. With the concentration of population and economic activity, urbanization permits the economic provision of high-capital cost distribution systems for modern fuels (chiefly petroleum products, natural gas or LPG). Urbanization provides the opportunity for increased household incomes, either through employment in the formal wage economy or through remuneration for a variety of "informal" production and service tasks made possible by the breadth of urban markets. At the same time, traditional biomass fuels become more costly due to the increased distance from their rural sources. With higher incomes and improved access to modern fuels, urban households can more easily afford the cash outlays for modern fuels and the appliances to use them.

This phenomenon is the so-called "fuel transition" from traditional to modern household fuels.² This shift in fuel use creates strains on fuel supplies and redefines commercial energy markets. Thus, this transition is typically a central issue for national energy policy.

Because fuels are essential to maintenance and comfort in every household, and because in cities, unlike in rural areas, almost all fuels are market goods traded commercially, governments have an interest in the affordability of fuels for household use. This interest most often is expressed through policies for subsidization of fuels and electricity.³ The effectiveness of such subsidies hinges on an understanding of the nature and dynamics of the fuel transition.

The urban household fuel transition can be described as having two major dimensions: (i) the shift from biomass fuels to modern fuels, first kerosene and then bottled gas (LPG) and electricity, for the essential household task of cooking and (ii) the acquisition of electrical appliances and the consumption of increasingly high levels of electricity to operate them. These two dimensions of the household energy dynamic in the cities of the developing world have distinctive features.

Cooking fuel is required in every household that prepares its own food. As a corollary, it should be expected that changes in the ways households view meal preparation and eating in urban areas will have significant impacts on their use of cooking fuels.⁴ In the preparation of food, urban households normally have a wide choice of fuels along the continuum of the biomass-modern fuel spectrum (e.g., wood, charcoal, kerosene, LPG and electricity), all available in much the same market. The economic concepts of competition and fuel choice are therefore directly applicable. There are complications, however: the cost of competing fuels themselves may play a lesser role in consumer choice than factors such as the cost of cooking appliances which use those fuels, the convenience of alternative fuels, and the perceived safety or cleanliness of the fuels in typical domestic patterns of use. Economic theory based on consumer-utility maximization suggests the importance of relative fuel price and of income in household decision-making on fuel choice and use. These variables have been studied widely to derive econometric parameters for use in forecasting and policy, such as price and income elasticities. Most studies confirm the expected results that at higher income levels, household use of modern fuels increases.^{5-10,2}

The consistency of this result belies the wide range of consumer responses to the variables of income and price, depending on many other factors. There is evidence, for example, that urbanization itself influences the selection of fuels.¹¹ Independent of price and income, some households in the developing world are also constrained by the availability of fuels. Indian cities have faced chronic problems with kerosene availability, leading to the imposition of a ration card system (requiring proof of residence), and lengthy queuing to obtain kerosene at the state-subsidized rates. As a result, some householders choose inferior or more costly fuels to avoid the inconvenience of relying on kerosene.^{7,12}

Electricity supply may be unreliable too, even if the customer has an official connection and meter. In many cities, chronic power shortages or poorly maintained distribution nets mean regular power outages or severe fluctuations in line voltage, which can damage household equipment. Unlike the case of cooking fuels, there are no adequate alternatives to electrical appliances in most domestic applications. For this reason, electricity is a highly prized service and one of the attractions of urban life in countries with low levels of rural electrification. Rapid increases in household use of electricity have been universally observed as household incomes rise and more appliances are acquired.^{13,5,9}

The poor can also face first-cost barriers to the adoption of high-quality modern fuels, such as electricity and LPG. To gain access to these fuels, the household must first make a cash payment in the form of a connection fee, meter installation charge, or deposit on a steel-pressure cylinder for fuel storage. Kerosene or charcoal may be preferred fuels, specifically because they can be bought in small quantities when only small amounts of cash are available. Ironically, the poor may end up paying more for equivalent heat value than the wealthy pay for high-quality preferred fuels.^{12,7} Two major factors explain this occurrence: (i) low-quality fuels burn less efficiently when used, and so more is required to perform the same task and (ii) when purchased in small quantities at the end of a chain of several distributors, retail fuel prices are higher.^{12,14}

The fact that modern fuel use in households increases with income obscures the relationship of income to changes in house size and type, appliance ownership and use patterns, as well as to changes in social interaction within the household unit. Increase in

income is not a direct cause of higher energy use because fuels are not consumption goods in and of themselves. What increases is the demand for the services that fuels provide: comfort, convenience, food preparation and entertainment. A more useful framework for energy investigations recognizes that energy use depends, not upon household income *per se*, but on the demand for more household services and on the characteristics of energy-using equipment.¹⁵

In addition, the dynamics of household energy use also are affected by the aggregate socio-economic changes that accompany urbanization and development. These permit the steady reduction in the cost of modern fuels and appliances as infrastructure investments take place, and better manufacturing and distribution systems are adopted. These systemic effects reinforce the impact of changes in income for each individual household.¹²

Consumer choices of appliance types and utilization are also shaped by traditions (e.g. culinary style) and values (e.g. the importance of social status and the ways in which status is acquired and demonstrated). Variations in fuel choice and energy use can be related to, for example, customary foodstuffs and cooking styles. But appliance acquisition and use is also partly an expression of aspirations for modern, bourgeois lifestyles, and of the achievement of socio-economic status.

Patterns of household energy use in developing world cities seem to be affected by all these factors: urbanization and economic context, household incomes, prices, technologies, household size, availability and reliability of alternative fuel supplies, cooking habits, food preferences and socio-cultural values. These patterns of household fuel choice have important economic and environmental implications. This is especially true in the poorer, so-called Less Developed Countries (or LDCs), where economic activity is less diversified and typically concentrated in a small number of large metropolitan centers. Their size alone justifies attention to such cities and the energy choices of their inhabitants; with millions of households involved, a shift of a few points in fuel demand can require a new power plant, or cause a significant impact on balance of payments deficits.

II. THE HOUSEHOLD SECTOR IN NATIONAL ENERGY PLANNING

The household sector ranges in size from 30% to 95% of total energy consumption in the developing countries, with the proportion highest in the poorest and least industrialized nations where fuelwood is the dominant source.² The importance of the household sector in aggregate national energy use eventually declines with industrialization and the adoption of modern fuels.^{5,9} But in countries that are urbanizing rapidly and experiencing strong growth in average household income, it is often the household sector that exhibits the highest aggregate rate of growth in electricity use, as consumers acquire Western-style appliances and lifestyles.¹³

Per capita use of modern fuels in the household sector has been increasing rapidly. In many respects this evidence is encouraging. It suggests that the number of LDC households with access to cleaner and more convenient modern fuels is growing. This change represents a gain in living standards and quality of daily life for these households. But there are problems as well. Growth in demand for modern fuels can exceed the capacity of the economy to deliver the needed energy, leading to shortages. This is frequently the case with electricity supply, which is often further constrained by government policies that limit the behavior of public utilities and regulate the retail prices of electricity under conditions of natural monopoly. Electricity shortages can serve as a barrier to investment and output growth, particularly when economic activity and electricity demand are growing rapidly (as in India, China and the Philippines). Capital investments in energy-supply systems are among the most costly infrastructure-investment needs for development, and may represent a very high proportion of total foreign debt in countries that are already straining to meet foreign exchange requirements. In this way, rapid growth in energy demand places further strains on economic management.

III. HOUSEHOLD ENERGY USE AND THE ENVIRONMENT

Different types of household fuels have differing environmental implications. In cities, household fuels are almost entirely commercial. There is limited potential for collecting combustible materials for domestic fuels. The environmental damages related to urban fuel use therefore can be felt in areas remote from the city (as a result of the methods

of managing and supplying the basic fuel resources) as well as within the city itself, where the problems arise from the process of combustion inherent in fuel use.

The damage to forest resources caused by the over-cutting of firewood for urban markets has been widely reported in Africa and South Asia.¹⁶ Although most global deforestation is the result of agricultural colonization, large-scale commercial forestry and ranching, the demands of cities for fuelwoods can be very high in certain localities.¹⁷

A transition to fossil fuels, which relieves the pressure on forests, has the disadvantage of contributing to increased atmospheric concentrations of CO₂ and hence to global climate change. While there are a handful of radiatively active gases, both natural and anthropogenic, that contribute to this greenhouse effect, fossil fuel use has been identified as the principal agent of global climate change.

In addition, urban air quality is largely a function of the amount and type of fossil fuels used within the city. With the shift to modern cooking fuels, the problems usually do not focus on fuel use within the household, but on fuel use for personal transportation. Vehicle exhaust emissions contribute by far the largest share of pollution in many cities, including greenhouse gases of various types, particulates and smoke, carcinogenic hydrocarbons and toxic heavy metals (especially lead). The article in this volume by Sathaye, Tyler and Goldman provides further discussion of the health and economic costs generated by congestion and high levels of vehicle exhaust emission.

The issues presented above demonstrate a troubling paradox: increased energy use in cities, by reducing environmental quality, can threaten the productivity of the very economic systems that energy systems are intended to support. In this sense, continued growth in energy use along current patterns is ultimately unsustainable. This set of issues has become much more widely recognized, particularly among international agencies, but it has yet to yield consensus on policy action.¹⁸ Efforts to develop and implement environmentally benign systems of energy use are likely to occupy a more prominent place on the international development agenda in the coming decade.

This trend has been highlighted by the adoption at the United Nations Conference on Environment and Development (UNCED) of the Convention on Global Climate Change. While the Convention lacked the strong targets and sanctions that some scientists had argued for, it does create a system of expectations and reporting requirements that will inevitably compel national governments to pay more attention to the local causes of this problem.¹⁹

IV. FINDINGS OF CITY STUDIES

Several key conclusions can be drawn from the set of articles contained in this volume. Each country has quite different policy contexts and, as one might expect, the fuel choice and energy-consumption characteristics of households in each country vary. The problems of household energy use and the potential mechanisms for addressing these problems are understandably unique to each country and even to each city. The emergence of some common patterns, therefore, is all the more remarkable given this variety in survey sites and developmental conditions.

The basic conclusion of the surveys is that in Asian cities the fuel transition is quite far advanced, with widespread access to electricity even among the poor. The use of modern cooking fuels is constrained primarily by lack of distribution systems. The use of biomass fuels is declining rapidly almost everywhere. One of the interesting findings is that, in most cases, the lower quality fuels that are being abandoned are not less expensive. In many cases, these fuels are actually more costly on a calorific basis than the high-quality, preferred fuels. Thus, the explanation of fuel choice becomes more complex: custom, cuisine, first costs of appliances or fuel containers and convenience seem to be greater barriers to the poor than fuel cost. In addition, factors such as the value of women's time take on growing importance as more and more women join the paid work force. The studies found that women often were willing to make higher investments in convenient fuels which offered time-saving benefits.

The willingness to pay for modern commercial fuels, if the supply is reliable, is quite high. This can be seen, for example, by the number of households that are still willing to pay high rates for basic electricity charged by landlords or meter owners. This gives an indication of the value of convenience, which respondents consistently claim is their most important criterion when considering a change in fuel technology. While the importance of convenient

use has been cited elsewhere⁴, survey respondents in these studies provide this as an explicit and important reason for fuel and appliance choice. The fuel transition is still related to income, but the reason seems to have more to do with limited access by the poor to higher quality fuel, and to the high first costs of appliances.

There have been dramatic increases in electricity use and appliance penetration across all income levels in most of the cities studied. Average household incomes have indeed climbed, but even at similar real income levels, a household today is much more likely to own major appliances than at any time in the past. There is also an increasing diversity in the household uses of energy, as new appliances are acquired to increase comfort or entertainment.

The results of the air quality studies suggest that the cause of indoor air pollution depends on fuels used for cooking/space heating. If cooking/heating is done with solid fuels, these are the primary sources of health-threatening indoor air quality. If liquid or gaseous fuels are used inside the home for cooking, then the main air quality problems, even in the house, appear to be more closely linked to outdoor air pollution (chiefly caused by vehicular transportation).

V. IMPLICATIONS

The willingness of the poor to pay for high-quality fuels suggests that fuel subsidies in urban areas are probably inappropriate. Instead of ensuring fuel supplies to the poor, these subsidies tend to condemn the poor to depending on fuels that even they do not like. With possible assistance for first costs of more efficient appliances, market forces would probably speed up the fuel transition (as LPG prices came down relative to solids or kerosene, for example). The marketplace plays a major role in energy use not only through fuel prices but through appliance selection and sales.

Electricity demand growth also must be addressed. Electricity dominates the residential household consumption picture whenever it is not subject to physical or infrastructure constraints, except in the very poorest households. The picture of appliance penetration and utilization in each case shows that while growth in electricity demand has been rapid, it is by no means nearing saturation (even in Hong Kong). Air conditioning is one of the most rapidly growing energy-using services in urban Asian households, with staggering implications for electricity demand in this sector. Benefits, such as greater indoor comfort, cannot be denied to users in developing countries, but the evidence suggests there may be considerable prospects for improved efficiency of electricity use, especially through the application of better technologies in new appliance design and manufacturing.

The same desire for convenience in personal transportation, although not yet affordable for the majority, is leading to massive traffic congestion, deteriorating air quality, and costly inefficiencies in the operation of the urban economy. As is the case for the urban household sector, great opportunities exist for improving the efficiency of urban transportation systems. In both areas, strong policy actions could have a decisive impact.

The research papers in this volume demonstrate the magnitude and urgency of the problems and point the way for further work on specific policy measures.

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