Energy for Low-income Settlements

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FOREWORD

The bulk of the population in developing countries is poor and survives on non-commercial energy sources such as fuelwood, agricultural residues or animal dung which are the most easily available and can be gathered at almost zero private cost. However, the exploitation of forests and natural fertilizers for energy needs leads to environmental degradation and consequent undesirable effects such as deforestation, soil erosion and desertification; in the case of excessive fuelwood removal, loss of nutrients and valuable fodder; in the case of burning of dung and agricultural residues, even damage to health. Rural poverty, aggravated by fuel shortages is driving villagers in numerous developing countries to shift to foods that require less fuel for cooking, although they are of low nutritional value, or even to miss some meals altogether and so go hungry. The shortages are also driving people in some areas to shift to food which can be eaten raw but is less nutritious, or to eat partially cooked food which could be toxic.

The situation of most urban poor is no better than that of the rural population. Since many slum-dwellers and squatters in Africa, Asia and Latin America are rural migrants with inadequate resources, they try to satisfy their energy needs in the same way as they had done in rural settlements: firewood and charcoal are the most commonly-used fuels for cooking and heating in the semi-rural squatter settlements on the outskirts of large urban settlements.

Strategies are, therefore, urgently required for implementation which address the issues of making increased energy available to the rural and urban poor and using available energy efficiently.

The United Nations Centre for Human Settlements (Habitat) has been making an unremitting effort aimed at alleviating the fuel crisis of the rural and urban poor. This publication is a continuation of that effort. Various studies, carried out over the years, have analysed the ways in which fuel scarcity for the poor is widening and deepening. They all tend to show that there are three types of possible solutions: increased biomass production, improved conversion efficiency and substitution by other fuels, i.e., switching. Possibilities exist for increasing the supply of biomass from homestead, crop and public land: planting of trees to increase the available supply of firewood for the local population is crucial to alleviating the domestic fuel crisis; the efficiency with which existing supplies of biomass are utilized can be improved through the introduction of improved cooking stoves or biogas plants; and, apart from producing additional biomass for fuel and utilizing existing sources efficiently, there may also be scope for relieving shortages by fuel switching. The three types of possible solutions could provide increased opportunities for setting up rural industries which would generate income and help in poverty alleviation. It is hoped that the publication will be found useful by policy makers as well as by officers and organizations involved in finding solutions to the energy problems of the poor and to the growing environmental questions posed by the existing energy–use patterns.

Gweet Romen

Dr. Arcot Ramachandran Under–Secretary General Executive Director

INTRODUCTION

Major changes in patterns of human settlements have always involved complementary changes in patterns of energy use. These changes have included interfuel substitution (switching), the development of new

technologies to utilize new fuels, and efficient ways of using old fuels. There have, often, been changes in the methods and organization of fuel transport. Figure 1 illustrates past and future trends in energy use in developed countries. These changes occur for a number of reasons, e.g., the discovery of new energy resources which stimulates interfuel substitution and the development of technologies to realise the potential of the new resource. Alternatively, as existing resources of energy become scarce, there is an incentive to find replacements as well as to conserve those existing resources.



Figure 1. The evolution of primary energy inputs mainly in developed countries as predicted by C. Marchetti, "Swing cycles and the global economy", *New Scientist*, May 1985.

Note: F is the fraction of total energy used

The major switch in the first 70 years of the twentieth century was the substitution of wood and coal by petroleum products and electricity, fairly rapidly in the developed countries and slowly in the developing world. Petroleum fuels have the advantage over wood and coal of higher energy content per unit weight, and they require simple and cheap conversion technologies. They also allow both goods and energy itself to be transported long distances. In addition, the development of low–cost oil–based fertilizers, in conjunction with low–cost and convenient energy sources, has ensured dramatic increases in agricultural output.

This pattern of growth altered when the price of oil significantly increased in the 1970s. Economic growth rates declined and many countries incurred large debts to finance oil imports. These increases in energy prices and the influence of excessive dependence on oil imports were the two main causes of the revival of interest in the development of and switching to alternative sources of energy, to use local resources, both renewable and non–renewable, and in the technologies to utilize these alternatives. Programmes were also initiated to reduce the consumption of oil–based fuels by improving the efficiency of end–use devices, and by better energy management practices. These measures, combined with a global decline in economic growth rates, managed to produce significant reductions in the growth of commercial energy consumption (1). Recently, the failure of oil–exporting countries to limit production has, together with these factors, prompted a decline in international oil prices.

Yet this decline in oil prices has not appeared to benefit the majority of people in developing countries. Most of the research and development on alternative sources and technologies has focused on the replacement of petroleum products consumed primarily by the developed countries and by high–income groups in the urban areas of the developing countries. Nevertheless, a some researchers have been closely examining patterns of energy consumption amongst the majority of the population in developing countries, i.e., rural people and low–income groups in the urban areas. Their work reveals that those who rely on woodfuels and other biomass material as their main source of energy, have been experiencing both shortages in and increasing costs of energy (2). Increases in population, changes in agricultural practices and over–exploitation of existing forests have led to increasing deficits in the supply of biomass sources of energy in many countries and regions.

In rural areas, people are finding wood difficult to collect and are being forced to cut live trees or substitute wood with residues, or residues with dung (3). For low–income groups in urban areas, especially where

charcoal and wood are major fuels, there have been increases in the prices of woodfuels commensurate with increases in prices of electricity and liquid fuels (see figure 2). These have often had a significant impact on disposable household incomes. Further, the shortages of both biomass, and sometimes, other fuels are often closely associated with land degradation and falling agricultural yields, further reducing incomes and employment.



Source: Biomass Energy Services and Technology (1984)

To assist developing countries in reducing petroleum imports, increasing the useful energy available to low–income groups and stimulating economic growth, many analysts have advocated programmes and technologies to encourage a switch from non–renewable to renewable sources of energy in the domestic, agricultural, industrial and transport sectors. Although funding has been limited, a number of technologies have been developed, and some renewable–energy programmes have been implemented. However, most funding has been for large hydro–electric schemes and, to a lesser extent, energy plantations (mainly wood and sugarcane). In most cases, the major part of the energy generated from such projects has been used by large industries, private transport or by high–income families. Relatively little funding has been allocated to programmes on alternative fuels or technologies appropriate or accessible to the rural poor such as small farmers, landless labourers or to low–income urban groups. Some programmes, for example, on improved stoves, tree production and power alcohol, have achieved their objectives, and there are instances of new technologies being introduced in relatively large numbers. However, on the whole, work on renewable energy sources and conversion technologies seems to have had little impact on patterns of energy consumption amongst rural and urban low–income groups.

A solution to the energy problems of human settlements requires revised and innovative strategies, namely, switching, emphasizing the rational use of non-commercial alternative energy resources and adoption of new technologies aimed at modernizing the use of traditional energy sources. There are wide variations in the potential supply and need for energy among different settlements: choice of technology and implementation have, therefore, to be tailored to the specific conditions of each settlement. Urgent attention should be given to ensuring an uninterrupted supply of the most appropriate energy to meet, at least, the minimum basic needs of the rural and urban poor and, wherever possible, to generate employment through setting up cottage industries.

I. TRENDS AND IMPLICATIONS OF ENERGY SWITCHING

Introduction

Energy switching can be implemented at different levels within the national economy. At a general level, switching implies a relative decrease in the use of one or more energy sources, with a corresponding relative increase in others. As these are relative changes, switching also occurs if the use of a given source or form of energy decreases, whether in a specific end–use or, generally, because of improvements in end–use

efficiency. Thus, broadly, there are two main categories of switching: (a) switching between renewable and non-renewable sources of energy; and (b) switching within categories of energy sources.

• Switching between renewable and non-renewable sources of energy includes:

(a) Replacement of a non-renewable source of energy by a renewable source of energy; for example, the use of wind to replace diesel fuel as a source of power for pumping;

(b) Replacement of a renewable source of energy with a non-renewable source of energy; for example, the replacement of charcoal and wood by LPG and/or kerosene as a source of heat energy for domestic cooking.

· Switching within categories of energy sources can involve:

(a) The replacement of one renewable or non-renewable energy source by another renewable or non-renewable energy source, for example, a switch from the use of wood to residues for domestic cooking in the renewable category. The switch may also be in terms of a shift in the quality of a fuel, as measured by its calorific value or convenience, for example, in the case of non-renewables, a switch from coal to a higher-grade fuel such as LPG for domestic cooking;

(b) A switch from a sustainable use of renewable energy sources, usually biomass, to a non-sustainable use of the same resource, trees being harvested more quickly than they are being replaced; or the soil being rapidly degraded by the continuous harvesting of an energy crop without replacement of the nutrients needed for soil fertility;

(c) A switch from one level of fuel efficiency to another, either higher or lower; for example, an improvement in cooking–stove efficiency, which reduces the amount of fuel needed for a given cooking task.

A. Present trends in energy switching and energy consumption patterns

Available evidence indicates that most or all of the switching processes mentioned above are occurring simultaneously in many countries. For example, in Bangladesh the following changes have been observed (3,4). In urban areas, middle–income and upper–income groups have been switching between non–renewable sources for domestic cooking from kerosene and electricity to LPG; industry has been switching both within non–renewables sources, from coal and oil to LPG; and from renewable to non–renewable sources, from wood to oil. In rural areas, with the recent rapid removal of tree cover, households and industry have been switching within renewable sources for mon–renewable sources for powers in some areas have been switching from non–renewable to renewable sources for power: from tractors, diesel pumpsets and diesel or electrically–powered process machinery to

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